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DEFINITION OF LIFE SCIENCES LABORATORIES FOR SHUTTLE/SPACELAB

VOLUME V • LIFE SCIENCES LABORATORY SYSTEM REQUIREMENTS DATA BOOK

BOOK 1 • SYSTEM REQUIREMENTS BOOK 2 • APPENDICES



GENERAL DYNAMICS Convair Division

REPORT NO. CASD-NAS-75-054

DEFINITION OF LIFE SCIENCES LABORATORIES FOR SHUTTLE/SPACELAB

VOLUME V + LIFE SCIENCES LABORATORY SYSTEM REQUIREMENTS DATA BOOK

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MAJOR ACRONYMS AND ABBREVIATIONS

ARC Ames Research Center

一個できるながらに、 きゅうしいない

BEST Bioexperiment Support & Transfer

CER Cost Estimating Relationship

CDMS Command and Data Management Subsystem

CIS Central Integration Site
COL Carry-On Laboratory

CORE Common Operational Research Equipment

CRT Cathode Ray Tube

CVT Concept Verification Test

EC/LSS Environmental Control/Life Support Subsystem

ECS Environmental Control System
EDC Experiment Development Center

EI Equipment Item

ESA European Space Agency G&A General & Administrative

GFE Government Furnished Equipment

GSE Ground Support Equipment HQTRS Headquarters (NASA)

IMBLMS Integrated Medical & Behavioral Laboratory Measurement System

JSC Johnson Space Center

K One Thousand (e.g., \$K or Kbits)

KSC Kennedy Space Center

LSPS Life Support & Protective Systems

M One Million
ML Mini-Lab

MSFC Marshall Space Flight Center MSI Man Systems Integration

MSOB Manned Space Operation Building

NR Non-Recurring

OPF Orbiter Processing Facility
PCR Payload Changeout Room
POC Payload Operations Center

RAM Research and Application Module

RAU Remote Acquisition Unit
R-O Recurring Operations (Cost)
R-P Recurring Production (Cost)

S/L or SL Spacelab

SRT Supporting Research & Technology
SPDA STS Payload Data & Analysis
STDN Space Tracking & Data Network
STS Space Transportation System

TDRS Tracking and Data Relay Satellite

WBS Work Breakdown Structure

BOOK 1 + SYSTEM REQUIREMENTS

1.0 INTRODUCTION

This document and updated versions of it are primarily intended to define the system requirements of the Life Science laboratories through various mission phases. Secondarily it can be used to acquaint the engineer, scientist, and program planner with the selected laboratory capabilities and limitations.

The system requirements of three selected Life Science laboratory concepts are defined for the mission phases of pre-launch, launch, on orbit, descent, and post landing.

2.0 LIFE SCIENCE LABORATORY CONCEPTS

The objective of having a family of Life Science laboratory concepts is to provide for program planning flexibility. This flexibility satisfies the science requirements as well as programmatic considerations.

The system requirements defined in this databook are based upon three classes of laboratories.

- 1. <u>Carry-On Laboratories (COL)</u> These laboratories are the smallest being considered and generally weigh less than 25 Kg. They have minimum interface requirements and can be installed in the Orbiter crew compartment. They are normally considered for flights of opportunity of seven days or less.
- 2. Mini-Lab These laboratories are intermediate in size and generally weigh less than 500 Kg. They are contained in one to several Spacelab equipment racks and have significant interfaces with the power, ECS, and CDMS. They are used on shared missions with durations from 7 to 30 days.
- 3. <u>Dedicated Laboratories</u> These laboratories are the largest being considered and may weigh as much as 2500 Kg. As the name implies these laboratories are dedicated only to Life Sciences research. They have extensive interfaces with the Spacelab subsystems. They may use as many as three discipline specialist on missions from 7 to 30 days.

The individual laboratory concepts defined during the phase A study are defined below. The system requirements are presented for one lab from each of the three classes. The selected laboratories for detail system requirement definition are: COL-2A, ML-1A and MOD-IA.

Lab Concept	Designation	Research Emphasis
Carry-On	COL-2A	Biomedicine
Carry-On	COL-3A	Biomedicine
Mini-Lab	ML~1A	Biomedicine (1st US/ESA Mission)
Mini-Lab	ML-2A	Biomedicine/Biology
Mini-Lab	M L-3A	Biomedicine
Mini-Lab	M L-4A	Life Support/Protective Systems
Mini-La b	M L;−5A	Man-Systems Integration
Mini-Lab	ML-2B	Biomedicine/Biology
Mini-Lab	M L-2C	Biomedicine/Biology
Mini-Lab	ML-2D	Biology
Dedicated Lab	MOD-IA	Biomedicine/Biology

Table 2-1. Life Science Laboratory Equipment Inventory

		Unit	Unit	Unit
E.I.		Weight	Power	Volume
No.	Equipment Item Name	kg	w	dm ³
i	ACCELERUMETER	0.1	0	0.03
IA	ACCELEROMETER COUPLER	0.05	1	0.01
ناد		SHUTT	Λ -	1
Ü	AIR PARTICLE SAMPLER	2.7	50	0.85
	AIRFLU URK SURFACE	5	75	6
7	AUTOANALYZER (GEMSAEC)	20	200	40
	AUTO POTENTIO. ELEC. ANAL.	12.7	100	57
11	ANALYZER, GENL. SPECTHOPHOT.	30	240	90
	AMESIMETIZER, INVERT.	11.2	0	ĺí
	ANTENNAS, ASSURTED	v.1	Ö	0.03
	ANTHROPOMETRIC GHID	1.8	Ĭŏ	2.9
	ATMUS. SAMPLING SYSTEM	10	20	58
	AUDIO STEREO HEADSET	6.7	o	5.7
	AUDIOMETER	4.5	Ž5	4.3
	BADGES, RACIATION	0.2	กั	0.1
	BALLISTOCARDIOGRAM COUPLER	0.1	í	1
	CUSTUM SITE BUARUS	(°.25	ō	0.03
	BODY MASS MEAS. BEVICE	36.5	15	675
25	CAGE, I WERTERRATES	0.3	0	0.2
	COLONY CHAMPER, SEALABLE	0.2	n	0.1
	CAGE, BELABOLIC, CAT	0 o Z	5	0.4
	CAGE METABOLICO PLANT	7	3 _U	
20t	CAGE NETABOLIC PATS		20 20	74.6
20 29	CAGE MEANT	بر 4.5	l'	28.3
	CAULO RATO HAMSTERO STANDARD		9	56∗೮
21	CALCULATOR POCKET	2.3		11
	CAMERA, CINE	U.47	0	0.4
		5	15	5
	CAMERA CONTROLLER CAMERA, MOLAROID	13.6	100	28.3
		3.3	0	5.6
	CAMERA, 35 Mm AND STRURE	5	0	2
	CAMERA, VIDEO, BYN Camera, Video, Color	4.4	15	3
	CAMERA HOUNTS	7.7	69	6.2
		3	0	3 3
	CAMERA TIMER, VIDEO CARDIOHOLMONARY ANALYZER	4	10	
	CENTRIPUSE DLD SMPL PROCESSOR	90.7	200	172
	CENTRIFUGE DIORESEARCH	12.7	100	25
		250	354	
44	CHEN A CALS	U.5	0	1.0
	CHEMICALS RAULOISOT. TRACFPS	5,0	. 0	0.5
	CHEMICAL STORAGE CABINET	4.0	0	14.1
	CLEANER, VACOUM	2.3	100	10
1	CLINOSTAT (FOR PLANTS)	3	10	20
	CLIMOSTAL (FUR CZT)	2	10	4
	COMPACION, SOLIDS	18	100	113
	COMPUTER, DIGITAL	SPACE	_	
	CONTROL CONSULE. EXPERIMENTER	22.7	100	113.3
	COOLANI LOOP, LIQUID	30	50	25
	COUNTER, COLONY, MANUAL	1.5	50	1.5
<u>55</u> ∧	CARW MUBILITY AIDS	SPACE	LAB	

Table 2-1. Life Sciences Laboratory Equipment Inventory, Contd

		Unit	Unit	Unit
E.I.		Weight	Power	Volume
No.	Equipment Item Name	kg	w	dm ³
55E		SPACE		ugu.
35C		SPACE	the state of the s	
Adc	DATA MONT SYST HUSES	SPACE		
	DES CONTROL AND DISPLAY STA.	SPACE		
	DAS REMOTE ACQUISITION UNIT	SPACE	The second of th	
	DISPLAY KEYBOARD, PURTABLE	13.0	60	42.5
53C	DISPLAT, NUMERIC	2	2	4
04	ECG COUPLER	0.2	2	0.5
co	EEG COUPLER	0.2	2	0.5
	ELECTRUPHYS. BACKPACK	0.3	0	0.25
	ELECTROPHYS. RECEIVER	2.7 .		5.0
UU	EMB COUPLER	0.2	2	0.5
09A	ELECTROALTER	5.7	3	7.3
70	ELLCTRUPHURESIS APPARATUS	9.1	85	25.5
100	EGULPHENT FESTRALAT DEVICE	0.5	0	1
7UE	EXERCISE EQUIP. PHYSIOL.	96	10	992
150	FILMS CINE	0.54	0	0.54
75F	FILM FULAPOID	0.10	ŋ	0.13
100	FILMS US MIN	0.13	n	0.05
100	FLOWILLIERS	0.5	1	0.5
/UL		4.5	40	19.0
77th	[18] [18] [18] [18] [18] [18] [18] [18]	21.0	10	74.1
υU	FREEZER, GENERAL	15	200	61.4
	FREEZER, LOW TEMP.	b	10	30.5
	FRIG. (RLFRIGERATOR)	1년	50	120
	GAS AWALTZER, INFRARED	11.5	5u	42.0
THE RESPONDED TO SERVICE STREET	GAS AMALYZER, MASS SPEC.	25	50	20
	GAS AMALYZER, KH	5.2	6	13
	GAS SUPPLIES	5.75	Ü	18
	GLOVE BUX PURTABLE	4.5	U	25
	GLOVE BOX LINERS	0.5	0	1
	HANDWIPES, BETADTHE	(1.3	0	0.3
	HOLDING UNIT, CELLS/FISSUES	23	30	188
	HOLD. O'ITTE INVERTEBRATES	23	50	183
	HOLDING UNIT, COMMON	20.4	5u	188
	HOLDING UNIT, PLANT	25	500	188
	HOLDING UNIT, MOTIKEY POD	53	100	425
	HOLDING UNIT, PRIMATE	113	100	340
	HOLDING UNIT: SM. VERT.	13.6	0	188
	INCUBATOR	5	5	8
	KITA WALLEN TO WAR AND AND AND AND	1.5	0	5
	KIT: MEMATOLOGY AND UROLOGY KIT: CLEANUP	5	Ü	G)
	KIII CLEANOP	1.5	0	4
	KIT, LINEAR MEAS.	1	n	1
	KII MACHUBIULUGY	1	0	1
	KII, MICKOGIOLOGY	2	0	3
	KIT, PLANT MANAGEMENT	3	0	8
	KIT, GENERAL TUOL	SBAC.	0	1
- 10 :	MATE OF ACIDAL TOOL	SPAC	L, AU	

Table 2-1. Life Sciences Laboratory Equipment Inventory, Contd

		Unit	Unit	Unit
E.I.		Weight	Power	Volume
No.	Equipment Item Name	kg	w	dm³
	KTT INVERT. MANAGEMENT	1	0	5 .
114A	KII DISSECTION	1	O	2
1146	KITA VERTEBRATE MANAGEMENT	3	0	6
1140	KIII VERTEBRATE PHYSIOLOGY	3	0	6
114E	LAMP, PORTABLE HI INT. PHOTO	6.3	150	6
1146	LIWULL STOR. AND DISPENS. SYS.	13	0	18
115F	LSS TEST CONSOLE	15	0	560
110	上の5・80045	0.5	O	0.4
117	LUNER DULT MEG. PRESS. DEVICE	78.7	20	2375
	LYOPHILIZER	23	300	143
	MINITOLIS VACOUM	9.1	0	28.3
	MSI TASK SIMULATOR	22.7	5	200
	MASS MEAS. DEVICE, MACKO	11.8	15	32.8
	MASS MENS. DEVICE. MICRO	12	15	25
	MASS, IEST, VARIABLE SIZE	U	0	י י
ACTUAL CONTRACTOR OF THE PARTY.	MEDIA, PREPARED	0.45	0	0.5
The second secon	MICKUSCOPE: COMPOUND	11	15	27.4
	MICKUSCOPE, DISSECTING	9	100	28
	MO-1110K. JIDEG	SPALE		
	MUDILLLY UNIT PROT. CORRIDOR	22.7	0	56.0
	MICH. ACCESS. KII. CUAPNU	10	15	25
	MCTORIZED PLANT GROWTH MONTTOR	0.5	5	0.6
	NON-VISUAL DIRECTION INDICATOR	4.1	0	2.8
	OPTISCAN - FIELD AND FIXED	2.3	5	8.5
A STATE OF THE PARTY OF THE PAR	UPH. FRUG CTUL. EXPER. PACKAGE	45	50	80
152	USCILLUSCOPE AND CAMERA	11.7	75 0	28.9
133	OTOLITA ILST GUGULES		0	
	PAPER, RECONSTRU	U•f· 1•8	20	1.2 5.2
	Pri METER	0.2	2	0.5
	PHOTOCILL COUPLER PHYSIOL. MULTICHAM. SEMS SYS.	0.2	0	1.4
	PLETHYS WORKARH, LIMB	2.4	5	6
		6.2	1	0.3
	PHONOVESKACARDIOGRAM COUPLER	20	5	15
	PEUMOTAGE LSS	30.4	6. 0	79
142	POWER COND. EGUIP.	SPAC		
	PRESSURE COUPLER	0.2	5	0.5
	PSYCHOROTOR PERFORM. CONSOLE	0.2	15	10.3
	PSTURIORALVANOMETER, USR	0.5	1	0.3
	RADIATION DETECTOR, DUSIM.	0.3	ŋ	0.5
	RADIATION COUNTER	15	50	20
	RAD. SOURCE, SHIELDED	65	5	28.3
	RECORDER, STRIP CHART	11.6	0	16.9
1.50A	RECEIVER, BIUTELEMETRY	0.5	10	1
195	RECORDER, VOICE	1	0	ī
1550	ROTATING LITTER CHAIR/CONSCLE	100.2	127	239
15 14	SENSURS, ASSURTED	0.5	0	0.3
	SIGNAL CUNDITIONERS (COUPLERS)	0.2	2	0.5
156	STOWAL CONDITIONERS (COOPLERS)	0.2	-	0.5

Table 2-1. Life Sciences Laboratory Equipment Inventory, Contd

E.I. No.	Equipment Item Name	Unit Weight kg	Unit Power w	Unit Volume dm ³
156F	SONOCARD LOGRAM	19	32	59
157	SOUND LEVEL METER	13.6	0	33.4
1560	SPACESUIT TEST CONSOLE	35	50	50
159	STAINING SYSTEM	2.2	0	3.5
	STEMILIZER + AUTOCLAVE	11	300	34.7
165	STERILIZER, FOOL	1	110	1 1
	STORAGE, GENERAL	SPACE		
167C	STURAGE, FILM	SPACE	LAB	
1/2	SPACESUIT	36.3	1	198.2
1/4	TANK , VENTEBICATE WATER	e,5°	5	28.3
1/5	TANK, PLANTZINVERT. WATER	1.7	0	3
1/6	TAPE, VIDEO	SPACE		
	TASKBUARD, FURCE/TURQUE	22.7	5	56.0
1/60	THERMOCOUPLE INDICATOR	b	8	9.4
1/9	TEMPERATORE BLOCK	4.5	200	1.7
	THERMOCOUPLES	₩.5	0	0.3
1790	THERMUMETER: ELECTRONIC	5,4	14	8.7
	TIMER, EVENT	0.2	0	0.2
ان101	TRANSDUCER# PRESSURE	0.2	1	0.4
	IRASH WAN	SPACE	LAB	
اعد 1	URINE VOLUME MEAS. SYST.	SHUT	LE I	
1020	VCG COOPLER	0.2	2	0.5
162K	VISION TESTER	22.7	100	113.3
	VENTILATION UNIT, VERT.	19	40	32.1
	VERTEURATE ECS) હત	320	121
1027	AIDEO LYHE KTCOMDEB	SPACE	LAB	,
	MULTIMETER	2	υ	2.+
	WASTE STURAGE DEVICE	SPACE	LAB	
1670	WOODLAND WAS DERRESONED	10	15	12.9
100	WORK AND SURGICAL REACH	136	1000	420

Lab Concept	Designation	Research Emphasis
Dedicated Lab	MOD-IIA	Biomedicine/Biology/ Adv. Technology
Dedicated Lab	MOD-IIIA	Biomedicine/Biology/Adv. Tech. & Centrifuge
Dedicated Lab	MOD-IIB	Biology/Biomedicine
Dedicated Lab	MOD-IIC	Biology/Biomedicine
Dedicated Lab	MOD-IIIB	Biology-Centrifuge/Biomedicine

Those concepts with multiple research emphasis, i.e., Biomedicine/Biology can accomplish either or both areas in a single mission. The actual emphasis will depend upon the experiment or research protocol for the specific mission. The 16 laboratory concepts presented have been scheduled into mission models that will be used for NASA planning. The inherent flexibility of the multi laboratory concept permits the development of new mission model combinations to meet various NASA programmatic requirements.

The common operational research equipment (CORE) inventory for all the above laboratory concepts is summarized in Table 2-1. Each selected laboratory equipment complement is presented in detail in the subsequent design portions of this document. In addition to the CORE certain equipment items will be added to the laboratory complement as PI supplied. These are experiment specific items that would be developed independently by the PI and are not definable at this time. An allocation in weight, power, and storage volume must be provided in each mini and dedicated laboratory for these PI supplied items.

2.1 CARRY-ON LAB 2A (COL-2A)

2.1.1 System Requirements Summary

The functional, operational, performance and design characteristics of the COL-2A during the various mission phases are summarized in Table 2-2. The details of these laboratory characteristics are presented in the following subparagraphs of this section.

2.1.2 Functional Requirements

This Carry-On Lab performs body fluid composition and electrolyte functions research by sampling, fractionating, preserving and returning for ground analysis, human blood samples.

2.1.3 Operational Requirements

The freezer (EI81) is operational from the time cryogenic coolant is loaded aboard at prelaunch until sample removal post-landing. This requirement implies power availability during ascent/descent, on-orbit and certain ground phases.

Table 2-2. System Requirements Summary (COL-2A)

LABORATORY	SYSTEM REQUIREMENTS BY MISSION PHASE						
CHARACTERISTICS	PRE-LAUNCH LAUNCH		ON-ORBIT	DESCENT	POST LANDING		
FUNCTIONAL (What does it do?)	Freezer operation required or pre- chill freezer module	Same as pre- launch	Biomedicine research. Cardiovascular	Support and maintain frozen samples	Same as descent		
OPERATIONAL (What are requirements to assure an effective and safe payload?)	No significant interaction	No significant interaction	Access required by crew during first day in orbit. Blood samples taken.	No significant interaction	Remove freezer and samples		
PERFORMANCE (What are reqmts. for power, data, ECS and environmentals?	Interface with power subsystem for blood centrifuge	Withstand 3g acceleration power needed during launch ≈10 Watts	Power: Avg. 10.42W Peak 110W Heat rejection equiv. to above power. No data mgt. required	Maintain cryogenics to freezer Power -10 W	Maintain freezer temperature -70°C		
DESIGN (What are requirements for equipment, configurations, and sizes?)	Install in orbiter crew compartment stowage racks. Vent ≈ 0.5 kg LN per day	Vent ≈ 0.5 kg	Weight 25.2 Kg 3 Volume 58.4 dm Vent ≈ 0.5 kg LN ₂ /day	Stow & restrain equipment for reentry Vent ≈ 0.5 kg LN ₂ /day	Design for easy removal of freezer and samples Vent ≈ 0.5 kg LN ₂ /day		

Table 2-3. Power Requirement Summary (COL-2A)

	LAB CODE: COL 2A		<u> </u>	ORBIT	OPERATION	S	ASCENT	DESCENI
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution		Watts	Watts
40A		100	.10	.42	100	10	0	0
81	Freezer (-70°C)	10	24	10	10	240	10	10
		110		10.42	110	250	10	10
						į		
							ļ !	
				<u> </u>				
						i		
						<u> </u>		

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Table 2-4. Equipment List

PAYLOAD BLOOD SAMPLING CARRY-ON

NO. COL-2A

EI#	EX NAME	Q	UNIT WEIGHT kg	UNIT POWER W	UNIT VOLUME dm ³
40A	Centrifuge, Blood Sample Processor	1	12.7	100	25
81	Freezer, Low Temp	1	8	10	30.5
106	Kit, Hematology & Urology	1	0.2	0	0.5
116	Log Books	1	0.5	0	0.4
	LN ₂ . (for EI 81)	1	3.8	0	2
	TOTAL WEIGHT		25.2		·
	·				

Crew requirements are minimal. Crewman, trained in drawing blood from fellow subjects, would suffice. Operating the blood sample centrifuge (EI 40A) and recording and labelling samples are easily trainable. Total operating time for this payload is estimated to be 0.5 hr during the first day and essentially zero thereafter.

2.1.4 Performance Requirements

This section deals with the power data, and environmental control factors associated with the carry-on payload.

2.1.4.1 Power and Energy Requirements

The power demands for this COL are attributed to two items; the centrifuge for blood processing, and the controls for the cryogenics used to maintain the desired freezer temperature. This power must be made available in the general stowage area of the crew compartment.

The average power consumption is 10.42 watts during the first day and 10 watts until unloading after landing. The peak power is 110 watts and occurs for about 3 minutes during the first day of the mission. Total energy required is about 240 watt-hours per day. Table 2-3 summarizes all the specifics of the power requirements.

2.1.4.2 Data Requirements

There is no CDMS interface support required for this payload. Data requirements are minimal and consist primarily of labelling samples and log book entries.

2.1.4.3 Environment Control Requirements

The heat rejection is equivalent to the electrical energy usage. The level is relatively low and will be rejected to the air in the crew compartment of the orbiter.

2.1.5 Design Requirements

The equipment list for the COL-2A is shown in Table 2-4.

The interface requirements include the power connection, and the venting provisions of the liquid nitroger from the dewar to the freezer and then the crew compartment.

2.2 Mini-Lab 1A (ML-1A)

2.2.1 System Requirements Summary

The functional, operational, performance and design characteristics of the ML-1A during the various mission phases are summarized in Table 2-5. The details of the laboratory characteristics are presented in the following subparagraphs of this section.

Table 2-5. System Requirement Summary (ML-1A)

LABORATORY		SYSTEM REQUIREMENT	rs by Mission Phase		
CHARACTERISTICS	PRE-LÄUNCH	LAUNCH	ON-ORBIT	DESCENT	POST LANDING
FUNCTIONAL (WHAT DOES IT DO?)	SUPPORT ORGANISMS OFO PACKAGE WITH POWER DATA & ENVIRONMENT. CAN BE LOADED 9 DAYS PRIOR TO LAUNCH. FREEZER OPERATION OR PRE-CHILL PRIOR TO LAUNCH.	SUPPORT ORGANISM OFO PACKAGE WITH POWER, DATA & ENVIRONMENT.	BIOMEDICAL RESEARCH IN THE AREAS OF: 1) VESTI- BULAR, 2) CARDIOVASCULAR 3) BIOCHEMICAL REACTIONS TO STRESS, 4) CELLULAR PHYSIOLOGY	SUPPORT ORGANISM OFO PACKAGE - MAINTAIN FROZEN SAMPLES	5. ME AS DESCENT
OPERATIONAL (WHAT ARE REQUIRE- MENTS TO ASSURE AN EFFECTIVE AND SAFE PAYLOAD?)	ORGANISM LOADING ON PAD DESIRABLE - ACCESS RECYD. ON PAD TO MONITOR AND CHECKOUT ORGANISMS ON A SCHEDULED BASIS, COORDINATE WITH OTHER SHARING DISCIPLINES.		NEED A MULTI-DISCIPLINE SPECIALIST FOR ≈2 HRS/ DAY. NEED LABORATORY (ML-IA) STATUS DISPLAYS, I.E., ENVIRONMENTAL CON- DITIONS.	NO SIGNIFICANT INTERACTION.	REMOVE FREEZER AND SAMPLES, REMOVE OFO PACKAGE WOODLAWN WANDERER.
PERFORMANCE (WHAT ARE REQUIRE- MENTS FOR POWER, DATA, ECS AND ENVIRONMENTAL?)	POWER - 65W CONTINUOUS 200W - 8 HOURS/DAY FOR FREEZER E180 DATA - 106 KBPS FOR 30 MIN EVERY HOUR ECS - PROVIDE HEAT RE- JECTION FOR ABOVE POWER CONSUMPTION. ENVIRONMENTALS - NO ESTABLISHED REQMTS.	*POWER REQUIRED 65W FOR OFO PACKAGES, FREEZER & WOODLAWN WANDERER, DATA 196KBPS CONTIN- UOUSLY. ECS - REJECT HEAT FOR ABOVE POWER. ENVIRONMENTALS - NONE SPACELAB + OFO PACKAGE PROVIDES ADEQUATE ACOUSTIC ATTENUATION. WITHSTAND LAUNCH LOAD OF 3 RACCELER,	· · · · · · · · · · · · · · · · · · ·	*POWER REQUIRE 65W (SEE LAUNCH FOR DETAILS) DATA - BUS RATE 106 KBPS ECS - REJECT HEAT FOR ABOVE POWER ENVIRONMENTALS-ROMTS. TO BE DEFINED.	MAINTAIN HABITABLE ENVIRONMENT FOR ORGANISMS. MAINTAIN FREEZER TEMPERATURE (-70°C)
DESIGN (WHAT ARE REQUIRE- MENTS FOR EQUIP., CONFIGURATIONS & SIZES?)	INSTALL EQPT. IN 1-1/3 SPACELAB RACKS + FLOOR MOUNTED RLC (.30 x .70 x .80 m) VENT ≈ .5 Kg LN ₂ /Day (FREEZER EI 81)	DESIGN FOR 3g ACCELER-	WEIGHT COMMON EQPT347 Kg TOTAL MINI-LAB: 497 Kg VOLUME 1-1/2 STANDARD SPACELAB RACKS EXPENDABLES 2.5 Kg LN2/DAY (FREEZER EI 81)	STOW AND RESTRAIN EQUIPMENT FOR REENTRY. VENT $\approx .5 \mathrm{Kg} \mathrm{LN}_2/\mathrm{DAY}$	DESIGN FOR EASY REMOVAL OF ORGANISM PKGS. AND FREEZER. VENT ~. 5 K, LN ₂ /DAY
<u> </u>			FLOOR MOUNTING PROVISIONS REQUIRED FOR THE ROTATING LITTER CHAIR DURING OPERATION.	· ·	
•	ENT POWER TO FIRST US/ESA ERY PENALTY USED 10 Kg/KW	_HR\		į	•

2.2.2 Functional Requirements

The functional characteristics during the non orbit phases of the mission are basically those which support the organisms and the freezer requirements.

During orbit the functional capability reflects the science requirements. This laboratory stresses biomedical research as defined in Table 2-6.

TABLE 2-6

Research Requirements	Specific Capability
Biomedicine	
Vestibular	Mechanical & neural responses of otolith organs to zero-g.
	Role of visual cues to space nausea.
	Role of altered body fluid volume, pressure & distribution to space nausea.
Cardiovascular	Gauer-Henry reflex.
	ECG, VCG, Pulse
	Anthropomorphic measurements of fluid shifts.
	Altered vascular flow, volume & pressure relationships.
Biochemical Reactions	Measure stress hormone, enzyme, fluid/electrolye & fluid volume changes.
Cellular Physiology	Single-cell type culture responses to zero-g — bone marrow.

2.2.3 Operational Requirements

The most significant operational requirement other than the need for a multi-discipline specialist for about 2 hours a day is the organism loading, access, and retrieval operations.

Ideally the principle investigators (PIs) desire on pad organism loading as late as possible in the launch countdown. Figure 2-1 presents the time lines associated with the presently recommended approach to all Life Science laboratory on-pad access requirements. This access is also the desired approach for ML-1A, however, there may be severe restrictions to on-pad access during the 1st US/ESA mission. This may require that the organisms be loaded in the Spacelab as much as nine days in advance of the launch. This early loading would require periodic monitoring and checking by ground personnel prior to launch.

The removal of organisms after landing is required within two hours. Several options have been investigated and are shown in Figure 2-2. Option 1 requires the ground crew to enter the Orbiter/Spacelab at the planned crew exchange at landing + 30

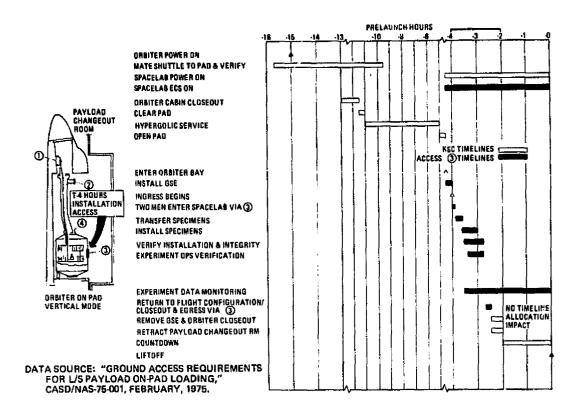


Figure 2-1. Life Science Payload Specimen Insertion On-Pad Access

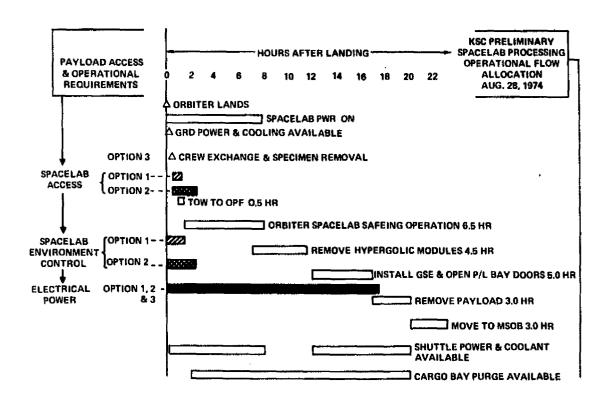


Figure 2-2. Postlanding Schedule - Spacelab

minutes and remove the organisms. Option 2 is the same as Option 1 except that instead of removing the organisms they are examined on board and data taken on the parameters of interest. Option 3 requires that the organisms be removed from the Spacelab prior to descent and stowed in the orbiter cabin and off loaded at the crew exchange. Presently Option 3 is recommended for mini-labs with small organism populations. Option 1 is recommended for the dedicated labs with larger organism populations.

2.2.4 Performance Requirements

This section deals basically with the power, data, environmental control and environmental factors associated with the payload. Because this is a mini-lab payload it represents only a portion of the total performance requirements of the Spacelab. The other sharing payload requirements must also be considered.

2.2.4.1 Power and Energy Requirements

Varying quantities of power are needed in all mission phases, i.e., prelaunch, launch, orbit descent and post landing. The most impacting are those requirements during prelaunch, launch, descent and post landing. The on-orbit requirements do not appear to result in any problems.

Table 2-7 summarizes the power requirements associated with all power consuming equipment items within the laboratory. The duty time for each equipment item is based upon an estimate of the nominal usage of the equipment item during the sevenday mission. The peak power is determined by combining those items that could be used simultaneously with the items that are nominally on 24 hours a day. The ascent and descent power requirements were minimized by allocating power only to those items required to maintain the organisms environment and the specimen freezer temperature. The total energy consumption of this laboratory is about 5 kW-hrs a day. This is about ten percent of that available to all the payloads.

2.2.4.2 Data Requirements

The data requirements cover all mission phases except the post landing. These data requirements will need either the Spacelab CDMS or separate recorders or both to be operational at various times during the non-orbit mission phases.

The data sources and requirements are shown in Table 2-8 for the on-orbit operations. The OFO experiment packages (131J) produce the highest data rates and the largest data amounts. Downlinking of this stream in real time is assumed, although recording and subsequent near real time transmission is acceptable.

A black and white video camera is also a part of this payload. Use and transmission to ground is assumed to be 0.25 hours/day.

Table 2-7. Power Requirement Summary (ML-1A)

LAB CODE: ML-1A	······································		ORBIT	OPERATION	S	ASCENT	DESCEN
•			Average		Energy		
Equipment Items	Operating	On Time	, -	Peak Power			
Using Power	Power (Watts)	Hrs/Day		Contribution		Watts	Watts
6A Airflow, Work Surface	75	.2	1.25		15	0	0
7A Auto. Poten. Elec. Analy.	100	1	8.33		100	0	0
37 Camera, Video B/W	15	.5	. 63	15	7.5	0	0
40A Cent. Blood Sample	100	.2	1.67		20	0	0
51F Coolant Loop, Liquid	50	24	50	50	1200	0	0
63C Display Numeric	2	8	1.33	2	16		lo
80 Freezer	200	8	66.67	200	1600	0	0
81 Freezer (Low Temp.)	10	24	10	10	240	10	10
14E Lamp. Port. Hi Int. Photo.	150	.5	6.25	150	75	0	0
26 Microscope	15	.5	.63		7.5	0	0
26J Microscope Ass. Kit	15	.5	.63	{	7.5	0	0
31J OFO Exp. Pack (2)	40	24	40	40	960	40	40
32 Oscilloscope	75	1	6.25		75	0	0
53A RLC/Console	127	.4	4.23	127	50.8	0	0
56 Signal Conditioners (6)	12	24	12	12	288	0	0
187A Woodlawn Wander	15	24	15	15	360	15	15
TOTALS	1001		224.87	621	5022.3	65	65
	Off Duty I	ower = 50	223-224.	7 x 12 = 193	7		
		_	12			<u> </u>	ł
stimated Crew Involvement							Į.
≈2 man-hrs/day during a 12-hour period		1	-		ļ		[
man arb, and anxing a re-perm portion							1
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		1	}	1		1	1

Table 2-8. Data Sources and Requirements (ML-1A)

PAYLOAD FIRST US/ESA SPACELAB MISSION M-L 1A

						SUPPORT NEEDED						
EI	NA ME	MEASUREMENT DESCRIPTION	FREQ OF	DURATION OF OPERATION	CONTINUOUS DATA RATE.	DAILY TOTAL bits	Pre-lumeh	Ascent	On-orthic	Descent Pest-launch	PROCESSING REQUIRED	REMARKS
7.4		Measure pH, pCO ₂ , pO ₂ , K, Ca, Na, Cl, glucose	2/day	0.5 hr	Negl.	5 K		ļ	×		Conversion to cone. values. Downlink.	
80,81	Freezers	Monitor temperatures	Once/10 min-	-	Negl.	зк			x .	×	Out-of-tolerance determination.	
131J	OFO Experiment Packages	8 Otolith signals 4 ECG signals Housekeeping	1/day	24 hr.	100 K	8640 M	x	×	x	x x	Transmission to ground. Real-time or near real-time.	Otolith channels sampled at 2000 samples/sec; ECG at 500 sps.
153A	Rotating Litter Chair	EOG/EMG, Controls	1/mission	0.5 hr Max. F	6.5 K ate 106 KBPS	11.7 M 8650 M			x		Transmission to ground.	
	REPRODUCIBILITY OF The ORIGINAL PAGE IS POOR			•								

2.2 4.3 Environmental Control Requirements

The environmental control is associated with 1) the rejection of heat equivalent to the power usage during all mission phases and 2) provisions for a habitable environment for in flight or ground crew members.

The on orbit heat rejection of 225 watts is rejected to the racks (96 W), the cabin air (12 W), and the experiment heat exchanger (117 W).

2.2.4.4 Environmental Factor Requirements

The environmental factors include such items as acoustics, vibration, shock, cleanliness, contamination, electrical, magnetic, and radiation. Except in a preliminary nature, these have not been established. The Spacelab environmental factors have been partially defined, however, the user requirements in terms of tolerance limits, have not.

2.2.5 Design Requirements

The laboratory is composed of 27 equipment items which are contained in 1-1/3 Spacelab racks plus a floor mounting for the rotating litter chair. Table 2-9 is the complete list of equipment along with estimates of the quantities, weight, power and volume. In addition to the common equipment which weighs 347 kg additional equipment consisting of racks, RAU's, power switch panels, converters, computer, interface hardware, and PI specific equipment brings the total weight to 497 kg.

The overall design must be compatible with the maximum launch acceleration of 3 g's. The freezer venting of approximately 0.5 kg/day must be considered in the pressurization and venting provisions of the Spacelab. The preliminary layout of the equipment within the racks is shown in Figure 2-3. The identification numbers on the layout indicate the equipment item numbers as presented in Table 2-9.

2.3 Dedicated Laboratory IA (MOD-IA)

2.3.1 System Requirements Summary

The functional, operational, performance, and design characteristics of the MOD-IA dedicated lab during the various mission phases are summarized in Table 2-10. The details of these laboratory characteristics are presented in the following sub paragraphs of this section.

2.3.2 Functional Requirements

The functional characteristics during the non-orbit phases of the mission are basically those which support the organisms holding units with power, data management and environmental control. The man surrogate testing requires that the organisms be exposed to the same environment as the crew. The Spacelab therefore must have a habitable environment during the non-orbit phases when the organisms are on-board.

Table 2-9. Equipment List (ML-1A)

PAYLOAD FIRST US/ESA SPACELAB MISSION

NO. M-L 1A

EI# EI NAME Q UNIT WEIGHT POWER W VOLUME W VOLUME WEIGHT POWER W VOLUME WEIGHT POWER W VOLUME WEIGHT POWER W VOLUME V VOLUM	NO.	M-L 1A				
6A Airflow Work Surface 7A Auto. Poten. Elec. Analyzer 7A Auto. Poten. Elec. Analyzer 7A Auto. Poten. Elec. Analyzer 7B 1 12.7 100 57 31 Calculator, Pocket 7B 1 0.47 0 0.4 36 Camera, 35 mm & Strobe 1 2 0 2 37 Camera, Video, B/W 1 4.4 15 3 40A Centrifuge, Blood Sample 1 12.7 100 25 51F Coolant Loop, Liquid 1 30 50 25 63C Display, Numeric 1 2 2 4 70C Equipment Restraint Device 1 0.5 0 1 76C Film, 35 mm 3 0.13 0 0.05 80 Freezer 1 15 200 61.4 81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 4 110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126 Microscope, Compound 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 1 10 15 12.9	1274	et name	6	WEIGHT	POWER	VOLUME
7A Auto. Poten. Elec. Analyzer 1 12.7 100 57 31 Calculator, Pocket 1 0.47 0 0.4 36 Camera, 35 mm & Strobe 1 2 0 2 37 Camera, Video, B/W 1 4.4 15 3 40A Centrifuge, Blood Sample 1 12.7 100 25 51F Coolant Loop, Liquid 1 30 50 25 63C Display, Numeric 1 2 2 4 70C Equipment Restraint Device 1 0.5 0 1 76C Film, 35 mm 3 0.13 0 0.05 80 Freezer 1 15 200 61.4 81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Microbiology 1 2 0 3	E1#	EI NAME	प	<u> 1745</u>	·	
31	6A	Airflow Work Surface	1	5	75	6
36 Camera, 35 mm & Strobe 1 2 0 2 37 Camera, Video, B/W 1 4.4 15 3 40A Centrifuge, Blood Sample 1 12.7 100 25 51F Coolant Loop, Liquid 1 30 50 25 63C Display, Numeric 1 2 2 4 70C Equipment Restraint Device 1 0.5 0 1 76C Film, 35 mm 3 0.13 0 0.05 80 Freezer 1 15 200 61.4 81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 9 110C Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E	7A	Auto. Poten. Elec. Analyzer	1	12.7	100	57
37	31	to the same of the	1	0.47	0	0.4
40A Centrifuge, Blood Sample 1 12.7 100 25 51F Coolant Loop, Liquid 1 30 50 25 63C Display, Numeric 1 2 2 4 70C Equipment Restraint Device 1 0.5 0 1 76C Film, 35 mm 3 0.13 0 0.05 80 Freezer 1 15 200 61.4 81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 9 106A Kit, Microbiology 1 2 0 3 110C Kit, Microbiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126	36	Camera, 35 mm & Strobe	ŧ =	2	0	
51F Coolant Loop, Liquid 1 30 50 25 63C Display, Numeric 1 2 2 4 70C Equipment Restraint Device 1 0.5 0 1 76C Film, 35 mm 3 0.13 0 0.05 80 Freezer 1 15 200 61.4 81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 9 106A Kit, Microbiology 1 2 0 3 110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 126 Microscope, Compound 1 11 15 27.4 126J	37	Camera, Video, B/W	_	4.4		
63C Display, Numeric 1 2 2 4	40A	Centrifuge, Blood Sample	1	12.7	100	25
70C Equipment Restraint Device 1 0.5 0 1 76C Film, 35 mm 3 0.13 0 0.05 80 Freezer 1 15 200 61.4 81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 4 110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80	51 F	Coolant Loop, Liquid	1	30	50	25
76C Film, 35 mm 3 0.13 0 0.05 80 Freezer 1 15 200 61.4 81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 4 110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9	63C		1	2	2	
80 Freezer 1 15 200 61.4 81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 4 110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 10.2 2 0.5	70C	Equipment Restraint Device	1	0.5	0	1
81 Freezer, Low Temp. 1 8 10 30.5 106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 4 110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2	76C	Film, 35 mm	[3	0.13	0	0.05
106 Kit, Hematology & Urology 1 5 0 9 106A Kit, Cleanup 1 1.5 0 4 110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System 1 10 <td< td=""><td>80</td><td>Freezer</td><td>1</td><td>15</td><td>200</td><td>61.4</td></td<>	80	Freezer	1	15	200	61.4
106A Kit, Cleanup 1 1.5 0 4 110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System 1 10 15 12.9	81	Freezer, Low Temp.	1		10	30.5
110 Kit, Microbiology 1 2 0 3 110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 187C Woodlawn Wanderer 1 10 15 12.9	106	Kit, Hematology & Urology	1	5	0	9
110C Kit, Human Physiology 1 3 0 8 114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 1 10 15 12.9	106A	Kit, Cleanup	1	1.5	0	4
114E Lamp, Portable Hi Int. Photo 1 6.3 150 6 116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 1 10 15 12.9	110	Kit, Microbiology	1	2	0	3
116 Log Books 1 0.5 0 0.4 126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 1 10 15 12.9	110C	Kit, Human Physiology	1	3	0	8
126 Microscope, Compound 1 11 15 27.4 126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 1 10 15 12.9	114E	Lamp, Portable Hi Int. Photo	1	6.3	150	6
126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 1 10 15 12.9	116	Log Books	1	0.5	0	0.4
126J Microscope Accessory Kit, Compd. 1 10 15 25 131J OFO Experiment Packages 2 45 20 80 132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 187C Woodlawn Wanderer 1 10 15 12.9	126	Microscope, Compound	1	11	15	27.4
132 Oscilloscope & Camera 1 11.7 75 28.9 153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 1 187C Woodlawn Wanderer 1 10 15 12.9	126J	Microscope Accessory Kit, Compd.	1	10	15	25
153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 1 10 15 12.9	131J	OFO Experiment Packages	2	45	20	80
153 Recorder, Voice 1 1 0 1 153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System In Orbiter 1 10 15 12.9	132	Oscilloscope & Camera	1	11.7	75	28.9
153A Rotating Litter Chair/Console 1 100.2 127 239 156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System 187C Woodlawn Wanderer 1 10 15 12.9	153	Recorder, Voice	1	1	0	1
156 Signal Conditioners (Couplers) 6 0.2 2 0.5 182E Urine Volume Measurement System 1 10 15 12.9	153A	_	1	100.2	127	239
182E Urine Volume Measurement System In Orbiter 187C Woodlawn Wanderer 1 10 15 12.9	156		6	0.2	2	0.5
187C Woodlawn Wanderer 1 10 15 12.9	182E	, , ,		In Ori	iter	ĺ
TOTAL WEIGHT 347		•	1	10	15	12.9
		TOTAL WEIGHT		347		
					1	
						l
		•				

Figure 2-3. First US/ESA Mission M-L 1A

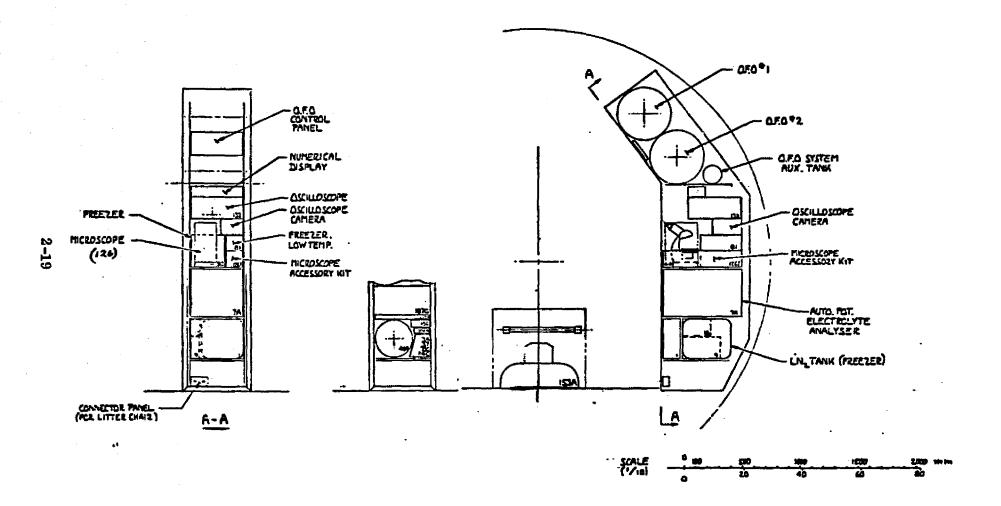


Table 2-10. System Requirement Summary (MOD-IA)

			SYSTEM BQU	REMENTS BY MISSION PHASE		
LABORATO CHARACTER		PRE- LAUNCH	LAUNCH	ON-ORBIT	DESCENT	POST LANDING
FUNCTIONAL (WHAT DOES IT	r 90?)	SUPPORT ORGANISM HOLDING UNITS WITH POWER, DATA AND ENVIRONMENTAL REQUIREMENTS. FREEZER OPERATION OR PRE- CHILL PRIOR TO LAUNCH EIS 77B & %1	SAME AS PRE-LAUNCH	BROMEDICAL RESEARCH IN VESTI- BULAR, MUSCULOSKETAL PULMON- ARY, HEMATOLOGY, MICROBIOLOGY CREW PERFORMANCE ON MAN, MAN SURROGATE EXPERIMENTING WITH PRIMATES, SMALL VERTE- BRATES AND CELLS AND TISSUES,		SAME AS DESCENT.
OPERATIONAL (WHAT ARE REG TO ASSURE EF AND SAFE PAY	Quirements Fective	ORGANISM LOADING ON PAD RE- QUIRED, ACCESS REQUIRED ON PAD TO MONITOR AND CHECKOUT ORGANISMS ON A SCHEDULED BASIS. CERTAIN BIOLOGICALS TO BE LOADED INTO COLD STORAGE FREEZER OR REFRIGERATOR.	NO SIGNIFICANT INTERACTION DEFINED. ENVIRONMENTAL FACTORS., I.E., ACOUSTICS VIBRATION, EMI, ETC., NEED TO BE SPECIFIED BY SCIENTISTS.	REQUIRES 3 PAYLOAD SPECIALISTS WORKING A 12-HOUR DAY, ENVIRONMENT REQUIRED TO SUP- PORT SPECIALIST, STATUS DISPLAY AND WALNINGS REQUIRED OF SPACEL AS CONDITIONS AND ENVIR- ONMENT,		REMOVE ORGANISMS, REMOVE FREEZER AND SAMPLES, PROVIDE A BIOENPERI- MENTAL SUPPORT & TRANSFER UNIT.
PERFORMANCE WHAT ARE REC FOR POWER, I AND ENVIRONS	QUIREMENTS DATA, ECS	POWER - 412W TO SUPPORT HOLD- ING UNITS, FREEZERS AND COUPLERS + SPACE LAB LIGHTING DATA - \$20 K RPS FOR 30 MINUTES EVERY HOUR ECS - PROVIDE HEAT REJECTION FOR ABOVE POWER + 175W MET- ABOLIC. VENTILATION FOR ORGANISMS AND GROUND CREW DURING LOADING. ENVIRONMENTALS - NO ESTAB- LISHED REQUIREMENTS.	POWER - 412W REQUIRED FOR ITEMS LISTY D IN PRE-LAUNCH STATE. DATA - ≈ 30 KBPS CONTINIOUSLY ECS - REJECT HEAT FROM A ROVE POWER PLES 179W METABOLIC HEAT. ENVIRONMENTALS - NONE DEFINITION ENCEPT 120 db ACOUSTIC LEVEL. WITHSTAND LAUNCH LOADS OF 3G ACCELERATION.	POWER ON DUTY AVG1376W ON DUTY PEAK -3216W OFF DUTY AVG672W OFF DUTY PEAK -836W DATA BUS RATE 70 KBPS ECS REJECT REAT FOR ABOVE POWER	POWER 472 W REQUIRED, FOR ITEMS LISTED IN PRE-LAUNCH STATE. DATA - ≈ 30 KBPS CONTINUOUSLY LCS - REJECT HEAT FROM ABOVE POWER PLUS 175W METABOLIC LOAD. ENVIRONMENTALS - REQUIREMENTS TO BE DETERMINED.	MAINTAIN A HABITABLE ENVIRONMENT FOR ORGANISMS, MAINTAIN FREEZER TEMPERATURES - 70°C POWER - 412W DATA -= 30KBPS FOR 36 MINUTES EVERY HOUR.
DESIGN WHAT ARE RE- FOR EQUIPME ATION AND SIZ	NT CONFIGUR	INSTALL EQUIPMENT IN 16 SPACE- LAB RACKS - FLOOR MOUNT ROTATING LITTER CHAIR, WORK & SURGICAL BENCH, & EXERCISE EQUIPMENT VENT = .5 kg LN_/DAY FREEZERS 7TB & %1	DESIGN FOR 2G ACCF LERATIONS, VENT ≈.5 kg LN ₂ /DAY	WEIGHT COMMON EQUIPMENT - 1904 kg TOTAL PAYLOAD \$315 kg YOLUME 16 SPACE LAB STANDARD RACKS + FLOOR MOUNTING FOR ROTATING LITTER CHAIR, WORK & SURGICAL BENCH, AND EXERCISE EQUIPMENT EXPENDABLES 7.5 kg LN2/DAY FREEZERS 77B & 81	STOW AND RESTRAIN EQUIPMENT FOR REENTRY, VENT \$.5 kg LN ₂ /DAY	DESIGN FOR EASY REMOVAL OF ORGANISM HOLDING UNITS AND FREEZERS VENT ±.5 kg LN ₂ /DAY

During orbit the functional capability reflects the science requirements. The MOD IA lab is a 7-day, biomedical emphasis mission. Man-related studies will be undertaken from two distinct, though related, orientations:

1. As a human organism requiring scientific investigation and measurement:

To understand the mechanisms of man's responses to space flight and his capability to adapt to the space environment. Special emphasis will be placed on those organ systems which have been found from previous flights to be influenced by gravity, e.g., cardiovascular, vestibular, and musculo-skeletal systems. Biological periodicities will be examined within the limits of mission profiles.

Animal models will provide information concerning basic mechanisms not easily determined in man. Such animal models would provide information in areas where measurements have not been developed for use in humans or would carry a significant hazard if utilized in man.

2. As an important (human) element of a flight system whose total performance capability is reflected in the performance level of that (human) system, and whose safety is of primary concern in any manned system:

To acquire, analyze, and interject data relevant to the problems of human performance, capability and behavior in space. This includes both group and individual behavior, attitudes, motivational levels, anxieties, etc.

To establish operator capabilities and requirements as they impact total system performance and crew safety.

To collect high fidelity, high quality data on the new population of space flight participants in order to substantiate and improve on the original medical selection criteria for Shuttle passengers and crews.

The specific research capability of the laboratory is summarized in Table 2-11.

TABLE 2-11

Research Requirements	Specific Capability						
Vestibular	Investigate role of visual cues in space nausea. Repeat of Skylab M131 experiment. Rotating Litter Chair. Role of altered body fluid volume, pressure and distribution to space nausea. Urine sample collection and analysis.						

TABLE 2-11 (Continued)

Research Requirements	Specific Capability
Cardiovascular	Altered vascular flow, volume & pressure relation- ships in zero-g. LBNP, VCG.
	Demonstrate presence or absence of Gauer-Henry reflex. Early mission urine/blood sample collection and analysis. APE, Freezers.
	Regulation responses to exercise in zero-g.
Pulmonary	Altered pumonary volume/flow/relationships in zero-g.
Musculo skeletal	Exercise effect upon musculoskeletal derangement. Diet and pharmacological control of musculoskeletal derangement.
Hematology	Collect, prepare & preserve blood samples. Determine red cell mass, recitulocyte counts, pCO ₂ , pO ₂ , pH, enzymes, proteins, etc.
Microbiology	Effects of space environment upon host defense mechanisms. Microbial sampling, culturing, staining, examination.
Crew Performance in Space	Time and motion studies, training tasks. Time relate performance measures with daily activity schedules, sleep patterns, environmental conditions and biomedical measurements.
Effects of Training upon Crew Efficiency	Correlate crew performance efficiency measurements with same tasks conducted in ground based simulators or prior missions.

2.3.3 Operational Requirements

The most significant operational requirement is the need for three payload specialists on duty 12 hours a day during on-orbit operations.

The requirement for organism loading, prelaunch access, and post launch retrieval have a significant effect upon the ground operations.

Ideally the PIs desire on-pad organism loading as late as possible in the launch countdown, Figure 2-1 (previously presented in paragraph 2.2.3) presents the time lines associated with the presently recommended approach to all Life Science on-pad access requirements.

The removal of organisms after landing is required within two hours. Several options have been investigated and are shown in Figure 2-2 (previously presented in paragraph 2.2.3). Option 1 requires the ground crew to enter the Orbiter/Spacelab at the planned crew exchange at landing + 30 minutes and remove the organisms. Option 2 is the same as Option 1 except that instead of removing the organisms they are examined on board and data taken on the parameters of interest. Option 3 requires that the organisms be removed from the Spacelab prior to descent and stowed in the Orbiter cabin and off loaded at the crew exchange.

Option 1 is recommended for the dedicated labs, and Mod-IA specifically because of the relatively large organism populations.

2.3.4 Performance Requirements

This section deals basically with the power, data, environmental control and environmental factors associated with the payload.

2.3.4.1 Power and Energy Requirements

Varying quantities of power are needed in all ...ission phases. The most impacting are the 412 watts during the pre orbit phases and the 472 watts during the post orbit phase. The on-orbit average requirement of 1570 watts does not appear to result in any significant problems.

Table 2-12 summarizes the power requirements associated with all power consuming equipment items within the laboratory. The duty time for each equipment item is based upon an estimate of the nominal usage of the equipment item during the seven day mission. The peak power of 3210 watts was determined by combining those items that could be used simultaneously with the items that are normally on 24 hours a day. The ascent and descent power requirements were minimized by allocating power only to those items required to maintain and monitor the organisms and to maintain the proper specimen freezer temperature. The total energy consumption of this laboratory is 26.9 kW-hrs a day which is about 50% of the maximum available to the paylead.

2.3.4.2 Data Requirements

The data requirements cover all mission phases. The pre launch and post landing requirements are for about 30 KBPS for 30 minutes out of each hour. During ascent or descent the rate remains at 30 KBPS however it is continuous. The rate increases to 70.1 kbps during the on orbit phase of the mission. The non-orbit mission phase will require either the Spacelab CDMS or separate recorders or both to be operational to properly monitor the data sources.

Table 2-12. Power and Energy Requirement Summary

	LAB CODE: MOD 1A		ORBIT	ASCENT	DESCENT			
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution	•	Watts	Watts
1A	Accelerometer Coupler (3)	3	24	3	3	72		
6	Air Particle Sampler	50	.4	1.76		20		İ
6A	Airflow Work Surface	75	.5	3.12		37.5	ļ	1
7	Autoanalyzer	200	1.0	16.66	200	200		į
7A	Auto Potentiometer Elec. Analysis	100	1.0	8.34		100		i
16F	Ballistocardiogram Coupler	1	1.0	.08		1		
19D	Body Mass Measuring Device	15	, 2	.26	İ	3	ļ	1
30A	Cage, Rat (16)	144	12	144	144	1726		1
31	Calculator, Pocket	5	1.0	.42		5	į	
32	Camera, Cine	13	.5	54		6.5		
32A	Camera, Controller	100	12	100	100	1200	<u> </u>	}
37	Camera, Video B/W	15	12	15	15	180		1
38	Camera, Video, Color	69	1.5	2.88	69	34.5		1
38D	Camera Timer, Video	10	. 5	.42	10	5	ļ	1
38F	Cardiopulmonary Analyzer	200	1.0	16.66		200		Ī
40A	Centrifuge, Blood Sample Processor	100	.4	3.34		40		1
48	Cleaner, Vacuum	127	.4	3.34	į	40	ļ	
50A	Clinostat C/T	10	24	10	10	240	l	
50B	Compactor (Solids)	100	. 05	.42		5	l	
51 F	Coolant Toop, Liquid	50	24	50	50	1200		1
54	Colony Counter (Manual)	50	.5	2.08	1	25	i	į
63 B	Display Keyboard Portable	60	1.3	5.0	ļ	60		ļ
63C	Display, Numeric (2)	4	12	4.0	4	48		1
64	ECG Coupler (12)	24	24	24	24	576	12	12
65	EEG Coupler (4)	8	24	8	8	192	4	4
6 5 C	Electrophys. Receiver	5	1.0	. 42		5	_	•
66	EMG Coupler (6)	12	24	12	12	288	6	6
70 E	Exercise Equip., Physiol.	18	4	6		72	1	-
76J	Flowmeter, Gas (4)	16	.5	.66	ļ	8		
77B		10	24	10	10	240	10	10
BO	Freezer, General	200	1 8	66.67	200	1600]	1
81	Freezer, Low Temp.	10	24	10	10	240	10	10
83	Refrigerator	50	8	16.67	50	400		<u> </u>
91	Gas Analyzer, Mass Spec. (2)	50	12	100	100	1200	50	59

Table 2-12. Power and Energy Requirement Summay, Contd

LAB CODE: MOD 1A (Co	ont'd)		ORBIT	OPERATION	S	ASCENT	DESCENT
			Average	Ė	Energy		1
Equipment Items	Operating	On Time	, -	Peak Power	Consumption	į	
Using Power	Power (Watts)	Hrs/Day		Contribution		Watts	Watts
93 Gas Analyzer, RH	6	24	6	6	144		
98A Holding Unit C&T (2)	60	24	60	60	1440	}	60
101C Holding Unit - Primate (4)	400/120	12/12	400	400	6240	120	120
103B Incubator	5	24	5	5	120]	
114E Lamp, Portable Hi, Int. Photo.	150	.5	6.16	150	75]	1
117 LBNP	26	.4	.86		10.4	1	[
121 Mass Meas. Device (Macro)	15	.3	.38	1	4.5	-	
122 Mass Meas. Device (Micro)	15	.3	.38		4.5		
126 Microscope, Comp.	15	-5	. 62	İ	7.5		
126A Microscope, Dissecting	100	1.0	8.34	100	100		
126J Microscope, Access. Kit	15	.5	. 62		7.5		Į
132 Oscilloscope	75	1.0	6.26	1	75		•
138 PH Meter	20	.3	.50		6	į	[
138B Photocell Coupler (12)	24	24	24	34	576		
139 Plethysmograph, Limb	5	.5	.20	1	2.5		
143G Pressure Coupler (4)	8	24	8	8	192	1	1
147 Radiation Count - Biochemical	90	.5	3,76	1	45		1
150B Receiver, Biotelemetry	10	24	10	10	240		<u> </u>
153A Rotating Litter Chair/Console	127	.4	4.24	İ	50.8		1
156 Signal Conditioners (12)	24	24	24	24	576		
156F Sonocardiogram	12	1.0	1.0	Ì	12	İ	ļ
162 Sterilizer, Autoclave	300	1.5	37.5	[450	-	
165 Sterilizer, Tool	110	.4	3.66	[44		
179 Temperature Block	200	1.5	25	200	300	1	
179D Thermometer (Electronic)	14	.2	.24		2.8	i	
181D Transducer, Pressure (4)	4	24	4	4	96	[
182J Vectocardiogram Coupler	2	1.0	.16	-	2	i	
182P Ventilation Unit - Vertical (5)	200	24	200	200	4800	200	200
188 Work and Surgical Bench	1000	1.0	83.34	1000	1000		
TOTALS	4909		1569.96	3210	26907	412	472
		!		!	!		! -:-
On Duty is considered 12 hours.	20 10 077 00		_	-		;	ĺ
Off Duty Average Power = 26, 907 - 1569.	96 X 12 = 671.29	1	•		İ	i	į
- 12		!	:		•	<u>}</u>	ì
	i .	I		•		i	!

The data sources are summarized in Table 2-13 during the on-orbit phase of the mission. The major contribution comes from various physiological measurements such as ECG, EEG, EMG, EOG, & VCG. Downlinking of this data stream in real time is assumed although recording and subsequent near real time transmission is acceptable.

The MOD-IA laboratory is equipped with two black and white and one color video camera. Transmission of video signals to ground is assumed to be 4.0 hours a day.

2.3.4.3 Environmental Control Requirements

The environmental control system (ECS) requirements are associated with all mission phases. The ECS requirements include heat loads related to the power consumption and the metabolic loads of the experiment organisms. The metabolic ECS loads include elements of heat, humidity, oxygen, and CO₂ control.

The metabolic loads of the MOD-IA laboratory imposed upon the Spacelab environmental control system are summarized in Table 2-14.

TABLE 2-14

MOD IA - METABOLIC LOADS (4 Primates & 16 Rats)

Humidity	Oxygen *	CO ₂ *	Cabin Air
Production grams/day	Consumption grams/day	Production grams/day	Interchange dm ³ /min
292 8	1932	2262	2120

During the prelaunch and launch phase of the mission 320 watts of heat from the holding units (EI 101C) and the ventilation units (EI 182P) along with 179 watts from the metabolic load is rejected to the cabin air. The descent phase is the same except for an additional 60 watts from the holding unit (EI 98A).

The other heat loads during these non orbit phases of the mission amount to 92 watts and are rejected to the avionics heat exchanger. In addition to the above heat and metabolic loads provisions must be available to support the ground crew during pre launch and post landing operations.

During the on-orbit phase the heat loads are as shown in Table 2-15. The loads are indicated for the three available coolant loops. All heat loads are within the present Spacelab capability. The other ECS loads involving humidity, O_2 and CO_2 control require off-design performance studies of the Spacelab system to determine compatibility.

^{*}EI 182P provides this capability

	•							SUPPORT NEEDED					
EI	NAME	MEASUREMENT DESCRIPTION	FREQ. OF OPERATION	DURATION OF OPERATION	CONTINUOUS DATA RATE.	DAILY TOTAL bus	Pro-launch			Doncent	Post-Inunch	PROCESSING REQUIRED	REMARKS
	ECG, EEG, EMG Couplers	Conditions electrophysiological signals from organisms or man.	16 chis - 24/day 6 chis - 4/day	10 min. 0.5 hr	700 % 16 chis 3500 % 6 chis 25.2 K	161M 151M 312 M	1	1	į	x		Downlinking, waveform analysis, data compression and display.	Assume 6 high rate, 16 low rate chis.
	Signal Conditioners, Assorted Couplers	Miscellaneous physical and bio- physical measurements. Pressure, temps., flows, etc.	Once/min 24 hrs/day		3	252K	×	x	æ	×	x	Downlink, out-of-tolerance determi- nation, display.	Azsumė 35 chls.
77B/80 81/83/ 103B	Freezers/Refrig.	Monitor temperatures	Once/10 min.		Negl.	15K	×	×	*	x	x	Out-of-tolerance determination.	Assume 4 chis/Ei.
7	Automalyzer	Measures approximately 12 con- stituents of blood serum.	2/day	0.5	100	360K			×			Conversion to cone, values. Downlink.	
7A	Auto. Poten. Elec. Anal	Measure 8 properties of blood serum and/or urine.	2/day	0.5	Negl.	5K			I			Conversion to conc. values. Downlink.	
91	Mass Spectrometer(2)	Measure mass no. and peaks of trace contaminants and major atmospheric gases.		Continuous	600	52M	×	x	×	x	×	Downlink. Possibly some on-board analysis.	
	Gas Analyzer, Water Vapor Specific	Measure resistivity of humidity sensors.	Once/min.		Negl.	7K	×	x	x	×	×	Out-of-tolerance determination.	
65C	Electrophysiology Receiver	Monitors electrophysiological signals from subject.	1/day	1 hc	нк	44.5M			x			Downlink, waveform analysis and display.	
153A	Rotating Litter Chair	EOG/EMG	2/mission	0.5 hr	6.5 K	11.7M			×			Downtink.	
1EC	Exercise Equit/Phy.	Monitor ergometer speed, output. Treadmill speed. Assume 4 chls.	2/day	1 hr	5 () 4 chis	144K			x			Downlink, on board display & control.	Assume 4 chis, I sample/ sec.
	Cardiopolmonary Analyze	Measure 6 gases used in breath-by- breath respiratory analysis.	2/day	0.5 har	500 @ 6 chls	10.8M	ŀ		x			Conversion to cone. values. Downlink	
	LBNP, Limb Piethysmographs	Monitor pressures, temps., and Plethys, chis.	1/day	I hr	35	126K			×			On-board control of expmt. Downlink.	Assume 6 chis. Sample 1/sec.

2 - 27

Table 2-13. Data Sources and Requirements (MOD-IA), Contd

PAYLOAD DEDICATED LAB - BIOMEDICAL EMPHASIS (Cont'd)
NO. MOD 1A

	SUPPORT												
I]] 1	NE	EDE	ED	1		
1							Ę.		Γ		Post-launch		
1				DURATION	CONTINUOUS	DAILY	i i	Ę	Έ	ij	ᅤ		
1_			FREQ. OF	OF .	DATA RATE.	TOTAL,	į	356	٩ چ	ğ	į	PROCESSING REQUIRED	REMARKS
EI 1823	NAME VCG Coupler	MEASUREMENT DESCRIPTION Converts VCG signals	2/day	OPERATION 1 hr	bps 21K	151M	╀▀	Ť	Ţ	Ħ	H	Downlink, On-board waveform	ALMAKAS
182	ACG Conbar	Converts vcc signals	2/taxy	1111	211	13171	1		ľ		H	analysis.	
182P	Ventilation Unit, Vertebrates	Monitor flow, pressures, etc. Est. 6 sensors.	Once/min.		Negl.	43K	×	×	×	×	*	Out-of-tolerance determination.	
98A	Holding Unit, C&T	Monitor Temp.	Once/min.		Negl.	7K			×	z	×	Out-of-tolerance determination.	
50A	Clinostat, C&T	Monitor motor current	Once/min.		Negl.	тĸ			×			Out-of-tolerance determination.	
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	1												
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27-2

TABLE 2-15 MOD-1A THERMAL LOADS

Avionics	Experiment	Condensing			
Heat Exchanger	Heat Exchanger	Heat Exchanger			
watts	watts	watts			
562	200	808 + 179 *			

^{*}Metabolic load - 4 primates, 16 rats

2.3.4.4 Environmental Factor Requirements

The environmental factors include such items as acoustics, vibration, shock, clean-liness, contamination, electrical, magnetic and radiation. Except in a preliminary nature these have not been established. The launch environment for acoustics has been set at 120 db. The Spacelab environmental factors have been partially defined, however, the user requirements in terms of tolerance limits have not.

2.3.5 Design Requirements

The MOD-IA has 118 equipment items which is about 77% of the CORE inventory. This equipment inventory is contained in 16 Spacelab racks. Floor mounting is required for several equipment items namely the exercise equipment (EI 70C), rotating litter chair (EI 153A) and the work and surgical bench (EI 188). Table 2-16 is the complete list of equipment along with estimates of the quantities, weight, power, and volume. In addition to the common equipment which weighs 1904 Kg additional equipment consisting of racks, RAUs, power, switch panels, converters, computer, interface hardware, and PI specific equipment brings the total weight to 3315 Kg.

The overall design must be compatible with the maximum launch acceleration of 3 gs. The freezer venting of approximately .5 Kg/day must be considered in the pressurization and venting provisions of the Spacelab. The preliminary layout of the equipment within the racks is shown in Figure 2-4. Identification numbers in the layout indicate the equipment item numbers as presented in Table 2-16.

Table 2-16. Equipment List (MOD-1A)

		Q	Weight (kg)	Power (watts)	Unit Volume (dm ³)
1	VCCEFEDCHEARD	+	0.1	0	0.93
_	ACCELEPOMETED CONFLER	₹	0.05	i	0.01
<u>.</u>	111 T. I. I. I. I. I. I. I. I. I. I. I. I. I.	1	2.7	- Sŋ	C.45
	ATOFEON WORK SUPFACE	1	5	75	6
7	ANTOANALY FER (GEMEAFE)	1	26	200	40
74	AUTO FOTENTIO. FLEC. ANAL.	1	12.7	1.00	57
	ANTENNAS, ASSOPTED	1	0.1	0	0.03
	ATMOS. SAMPLING SYSTEM	1	10	20	28_
-	AUDTOHETE?	1	4+5	25	4.3
	BANGES, PANTATION	2	0+2	0	0.1
_	PALLISTOCARDIOGRAM COUPLER	1	0-1 0-23	1	1 8.03
	CUSTOM BITT BOAPRS BODY MASS MEAS. DEVICE	1	36.5	0 15	675
	COLONY CHAMPER, SEALABLE	20	0.2	Ô	0. i
	CAGE, RAT, HAMSTED, STANMARM	16	2.3	ÿ	11
	CALCHLATOR, PUCKET	i	0-47	g	0.4
	CA4FPA, CINF	i	5	13	5
	CAHEDA CONTROLLER	1	13.6	100	28.3
3.5	CAMERA, FOLAROTO	1	3.3	a a	5.6
	CAMERA, 35 MM AND STROBE	1	2	0	2
	CAMERA, VINEO, BIN	?	4.4	15	3
	CAMEDA, VIGEO, COLOD	1	7.7	69	6.?
	CAMERA MOUNTS	1	3	9	7
	CAMED TIMED, VIDEO	t	4	10	3
	CAPO TOPUL MONAPY ANALYZEP	1	90.7	206	172
	CENTRIFUGE, BUT SMPL PROCESSOR	1	12.7 0.5	186 3	25 1.0
	CHEMICALS PAGIOISOT: TPACEPS	1 1	0.3	9	0.5
	CHENICAL STOPASE CABINET	1	4-0	ð	14.1
	CLEANER, VACUUM	i	2.3	106	10
	GLTNOSTAT (FOP C/T)	ī	2	10	4
	COMPACTOR, SOLIDS	1	18	1 70	113
	CONTROL CONSOLE, EXPERIMENTED	1	22.7	100	113.3
	GOOLANT LOOP, LÍMIT	1.	30	50	25
FL	COUNTER, COLONY, MANUAL	i	1.5	50	1.5
	htsplay Keyscaro, Poptable	1	17.6	60	42.5
	TISPLAY, MUMERIC	2	2	. 2	4 -
	FOR COUPLES	12	0-2	?	0.5
	FFG CUIPLES	4	0.3	2 0	0.5 0.23
	EFECTAODHAS" STEKATER	1 1	2.7	25	5.0
	EAR CORDIES	6	1-2	2	0.5
	FOULPHENT PESTPAINT DEVICE	1	0.5	ō	1
	EXERCISE EQUIP., PHYSIOL.	ī	96	18	992
	FILM, CINF	4	ŭ.54	ā	0.54
	FTLH, FOLAROTO	5	0.16	3	0-13
	FTLM, 35 MM	10	0.13	3	€.05
	FLOWMETERS	4	0.5	1	0.5
773	FREEZER, CRYDGENIC	1	21.6	10	74.1
ĠΙ	EREF ZER, GENERAL	1	15	200	61.4
81	FREE FR. LOW TEMP.	1	8	10	30.5
	FRIG. (REFRIGERATOR)	1	18	5 0 5 0	127
	GAS ANALYZEP, MASS SPEC.	?	25 5 2	5 0 6	20 13
	GAS ANALYZES, TH	1	5•2 5•75	0	13
96	SAS SUPPLIES SLOVE BOX, POPEARLE	1	4.5	a	25
	SLOVE BOX LINERS	10	8.5	9	i
	HANDWIPES, BETADYNE	17	0+3	Š	9.3
	HOLDING UNIT, CELLS/TISSUES	ž	23	30	188
	HOLDING UNIT, PRIMATE	ī,	113	100	340
	,				

Table 2-16. Equipment List (MOD-1A), Contd

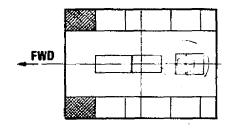
	Q	Weight (kg)		Unit Volume (dm ³)
163 HOLDING UNTT. SM. VERT.	3.	13.6	0	188
1839 THOUBATOR	1	5	5	5
105 KTT, CHEMICAL	1	1.5	0	5
106 KTT, HEMATOLOGY AND UPOLOGY	t	5	9	9
1064 KTT; CLEANUP	1	1.5	9	4
1CA KIT, HISTOLOGY	1	1	Ö	1
109 KIT, LINEAP MEAS.	1	1	0	1
116 KTT, MIGPORTOLOGY	1	2	Ċ	3
1100 KTT, HIMAN PHYSIDLOGY	1	3	7	8
1144 KIT, DISSECTION 1149 KIT, VERTEBRATE MANAGEMENT	1	L	0	2
1140 KIT, VEGTEGRATE PHYSIOLOGY	1 1	3 3	0	6 6
1145 LAMP, FORTABLE HI INT. PHOTO	i	6.3	ը 150	6
1146 LIDUIN STOP. AND DISPENS. SYS.	i	13	0	18
116 106 BCOKS	3	9.5	ž	0.4
117 LOWER BORY WEG. POESS. REVICE	1	78.7	3 F	2373
118T MANIFULD, VACUUM	1	9.1	.j	26.3
121 MASS MEAS. DEVICE, MACRO	1	11.5	15	32.8
122 MASS MEAS. DEVICE, MICRO	1	12	15	25
124 METIA, PREPADEN	3	0.45	9	0.5
126 MICROSCOPE, COMPOUND	1	11	15	27.4
126A MICPOSCOPF, TISSECTING	t	9	1 00	29
1263 MICP. ACCESS. MIT, COMPAN	1	10	15	25
171F NON-VISUAL DIRECTION THRICATOR	1	4.1	0	2.8
132 OSGILLOSCOPS AND CAMERA	1	11.6	75	23.9
137 OVOLITH TEST GOGGLES	1	0.2	Ū n	2.8
1348 PAPEP, RECOPMING	1).A 1.8	3	1.? 5.2
13M4 PHOTOCFLE CONFLET	1 12	0.5	\$ 20	0.5
13PF PHYSIGL. HILTIGHAN. SENS SYS.	į	0.2	ı̈́	1.4
179 PLETHYSMOGPAPH, LIHA	i	2.4	5	6
145 PHONCVIAPAGAPATOGPA4 COUPLES	1	0.2	i	0.3
141A PLUMBING	1	20	2	15
1430 DOESSIDE CONDERS	l _b	€.2	?	C.5
1440 PADIATION OFFERTOR, DOSIM.	1	0.3	Ĵ	0.5
147 PATIATION COUNTER	1	15	50	23
1504 PECCEPTES, STRIP CHART	1	11.9	3	16.9
1509 PECETVER, BIOTELEMETRY	1	0.5	1.0	1
157 OFGUORER, VOICE	1	1	0	1
1534 POTATING LITTER CHATP/CONSOLE	1		127	. 239
1570 SENSOPS, ASSOPTED 156 STENAL CONDITIONERS (COUPLERS)	1 12	6.5	3	0 • 3
156 STENAL CONDITIONERS (COUPLERS) 1565 SONCCARRIOGRAM	1 2	0.2 19	3 2 3 2	0•5 59
157 SOUND LEVEL METER	1	13.6	0	33.4
159 STAINING SYSTEM	1	2.2	งั	3.5
162 STEPTLITER, AUTOCLAVE	ī	11	305	34.7
165 STERTLIZER, TUDL	1	1	116	1
174 TANK, VERTERRAFF WATER	5	8.5	5	28.3
1769 THERMOCOUPLE INDICATOR	1	6	3	9.4
134 LEATEOUTHSE STOCK	1	4.5	50 G	1.7
1794 THERMOCOUPLES	1	G.5	Đ	0.3
1799 THEPMOMETER, FLECTRONIC	į	5.4	14	8.7
180 TIMER, EVENT	?	6.2	à	0.2
1419 TOANSTUCES, POESSHOE	4).2 2	1 7	0.4
1823 VOG COUPLES	1 5	9.2	5	0.5
1820 VENTILATION UNIT, VEPT. 165 MULTIMETER	, 1	19 2	% ())	32.7 2.4
188 WORK AND SUPCICAL BENCH	1	136	1009	423
and a second of the second of the c	-		A	7 1. 7

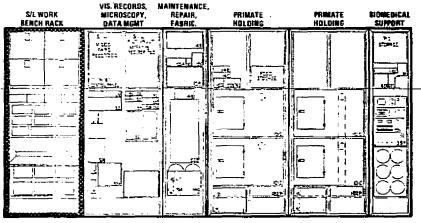
RESEARCH CAPABILITY

- BIOMEDICINE (MAN) CARDIOVASCULAR, VESTIBULAR, MUSCULOSKELETAL, ETC
- BIOLOGY HOLDING UNITS 4 PRIMATES, 2 SM. VERTS, 2 CELLS/TISSUES
- INFLIGHT ANALYSIS BLOOD, URINE CHEMISTRIES, SURGERY, MICROSCOPIC, PHOTOGRAPHIC
- RETURN FOR GROUND ANALYSIS —
 FREEZERS, FRIG.; HISTOLOGY,
 DISSECTION, MICROBIOLOGY,
 HEMATOLOGY KITS

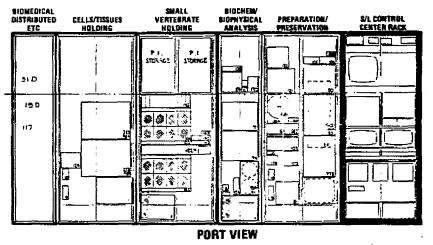
CHARACTERISTICS

COMMON FOMT WEIGHT - 1904 KG TOTAL P/L WEIGHT - 3314 KG AVERAGE POWER - 1500 WATTS USES ENTIRE S/L LONG MODULE





STARBOARD VIEW



09105CVF3662

Figure 2-4. Dedicated Laboratory Layout, MOD 1A - Biomedical Emphasis Lab

BOOK 2 • APPENDICES

BOOK 2 APPENDICES

	Appendix
LIFE SCIENCES RESEARCH REQUIREMENTS	A
RESEARCH CAPABILITY OF DEFINED PAYLOADS	В
LABORATORY AND BIORESEARCH CENTRIFUGE LAYOUT DRAWINGS	c
LABORATORY POWER AND ENERGY REQUIREMENTS	D
LABORATORY SAMPLED DATA REQUIREMENTS	E
EI GSE REQUIREMENTS	F

APPENDIX A

LIFE SCIENCES RESEARCH REQUIREMENTS

APPENDIX A

LIFE SCIENCES RESEARCH REQUIREMENTS

The tabular information presented in this appendix is the condensation of data from various input data sources, pertinent information from past studies, and summaries of life sciences research objectives. All these data were used to support the evaluation and recommendation of life sciences research requirements discussed in Volume II, Section 2. The data are organized as follows:

	Page
Time-Phased Life Sciences Research for Consideration on:	
US/ESA First Spacelab Mission	A-2
Carry-on and Mini-labs	A-4
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NASA/ARC, July 1975	A-26
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TIME-PHASED LIFE SCIENCES RESEARCH FOR CONSIDERATION ON US/ESA FIRST SPACELAB MISSION

Proliminary integrated Life Sciences Payloads for Shuttle/Spacelah through 1985, Prepared for Dr. Winter, 7 February 1975	Scientific Uses of the Space Shuttle, Space Science Board National Research Council, National Academy of Sciences, Washington, D.C., 1974
EFFECTS OF SPACE FLIGHT ON MAN	nomedicine
Evaluation of the Gauer-Henry reflex in large maximals Animal studies of shifts in body fluid & blood distribution Heman input/output water balance studies with respect to cardiovascular performance Anthropometric measures of cardiovascular fluid shifts Testing of inflight space masses countermeasuren Evaluate pro- and post-flight "space masses" screening tests to determine predictive value Hormonal & electrolyte assays to measure mineral & florid balance Follow-up studies in Skylab renal function observations Studies on bone marrow suppression in weightlessness Evaluate the effer diveness of types of exercise maintaining cardiovascular and muscular tone	Cardiovacular System (Expis in both animals and humans needed) Exercise effect on cardiovascular regulatory responses Starty of body fluid compartment volumes Surly possible atrophy of cardine & other muscles Respiration Study pulmonary vascular resistance Kithey & Metabolism Alchesterone secretion Body electrolytes Body fluid compartment volume measurement Bone formation in zero-g thone repair in animals) tematology Red blood cell mass measurement Bone morrow functional response to zero-g Neurology Study vestibular functions in man & animals Neurophysiological dysfunction (righting reflexes - cardiovascular)
lavasive animals studies to measure factors controlling postflight cardine output	
BIOLOGY (Designated as "Research" in above source)	BRANGA
Small verlabrate studies on the relationships of endocrine control of mammalian physiology	Physiological effects of zero-g on small mammals
Animal studies on the mechanisms involved in space nausen and vestibular adaptation to zero-g	

Test Subjects: Humans, Non-Human Primates, Small Mammals, Colls & Tissues Test Sobjects: Humans, Non-Human Primutes, Small Mammala, Colls & Tissues

> REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Life Sciences Payload Schedule. R. Jazzning, OMSF/MMS	The Proceedings of the Skylab Life Sciences Symposium, August 27-29, 1974, Vol. II, Report No. TM X-38164, JSC-09275, NASA-JSC. Comments from: "Skylab: A Beginning", Lawrence F. Dietlein, M.D., NASA/JSC
MEDICINE	BIOMEDICINE (CANDIDATE FUTURE STUDIES)
Sept. 1980 - UN/ESRO Lafe Sciences Lab. First major Life Sciences Laboratory to be flown in Shuttle. Research capitalizes on preliminary experiments flown cartier. Major upgrading: inclusion of man-surrogates for research in depth. Possible inclusion of fundamental biological research. Major Research Areas: vestibalar function, cardiovascular function, homotopoetic function dame marrow study). Additional Areas: urino volume measurement & preservation methods.	Cardiovascular System In-depth, noninvasive cardiovascular dynamics mentioring Invasive pressure/volume/flow changes in early flight (animal) Domonstrate presence or absence of Gauer-Henry reflex Total body exercise regimen to maintain integrity of antigravity as well as major muscle groups Assess role of venous (capacitance) vessels in observed deconditioning process Assess role of fatigue Musculoskeletal System Absolute catabolic in-flight changes (bone, muscles) in animals Countermeasure evaluation: Dictary Physical Physical Physical Inormal Fhitd/Electrolytes Renal hemodynamics in zero-g Renal response to water/salt leads, dehydration in zero-g Illumeral interactions involved in above
	Vestibular System Role of altered cues: visual, kinesthetic, other sensory Effect of evertydration, dehydration and increased venous pressure on motion sickness threshold Predictive test for zero-g space sickness susceptibility (? parabolic flights) Basic studies regarding etiology Role of one-g training in provention Improved medications for prevention/control

Test Sobjects: Humans, Non-Human Primates, Small Mammals, Colls & Tissues

Test Subjects: Humans, Non-Human Primates, Small Mammals, Cells & Tissucs

TIME-PHASED LIFE SCIENCES RESEARCH FOR CONSIDERATION ON CARRY-ON LABORATORIES/MINI LABORATORIES

Proliminary integrated Life Sciences Payloads for Sintile/Spacolab through 1985, Propared for Dr. Winter, 7 February 1975	Velocific Uses of the Space Stattle, Space Science Board, National Research Council, National Academy of Sciences,
EFFECTS OF SPACE FLIGHT ON MAN	Washington, D.C., 1974
Measurement of cardiopulmonary functions during spaceflight, using the cardiopulmonary analyzer	Cardiovascular System (Expls in both unimals & humans peeded) - Peripheral blood flow (LBNP)
Anthropometric measures of cardiovascular fluid shifts	Exercise offert on cardiovascular regulatory responses Study of body flutd compartment volunces Study possible attophy of cardiac & other muscles
Evaluation of new techniques to study cardiovascular fluid shifts	Respiration Respiration
Evaluatu pro and postilight "space nausea" screening devices to determine predictive value	Study pulmonary vascular resistance Kichny & Metabolism Aldestorone, insulin, & growth hormone secretion
Tost in-Right "space injuser" countermeasures Perform bermonal and electrolyte assays to measure mineral	- Body electrolytes & Buid compariment volume measurement - Bone formation in zero-g (bone repair in animals) - Effect of zero-g on layed metabolic rate
and fluid balance	Hematology Rud blood cell mass measurement
Study of microbial acrosol propagation in space	Bore marrow functional response to sure-g Blood grandocytic response to inflammatory stimuli Neurology
	Study vostibular functions in man & animals Nourophysiological dysfunction (righting reflexes - enrillovascula Microbiology Study of cultular immunity functions relative to host resistance ispectife immune response monitoring & record of host infections)
BIOLARIY (Dosignated as "Research" in above source)	Могон
Caribovascular studies of output; the role of venous vossels in deconditioning; boart contractility: Gauer-Honry roflex	Animal Biology - Physiological offects of zero-g on small mammals
Mutabolic studies of fluid a mineral balance; total body com- position; changes in bones, muscles & beart; mutabolic energy expenditure shifts.	
Fluid/oloctrolyte studies of renal function	
Romatological studies of Immuno response, marrow changes, red cell mass loss.	
(Through utilization of a solf-custained animal holding facility (Monkuy-Pod))	t
MAN/SYSTEMS INTEGRATION	MAN/SYSTEMS INTEGRATION
<u>Evaluation of Advanced Dasign Concepts</u> Evaluation of advanced crow restraint conce _t is Simulation 6 training optimization studies for man-machine tasks	Measure decreponts in performance Study interportental reaction patterns Mental alertness and performance & sleep patient relations
Experiment Support Engineent Design Evaluations Flight test of man-machine interface design criteria developed from Skylab results.	
has assumed of the radey, officiency, & effectiveness of laboratory becomings and procedures	
	·

Test Subjects: Humans, Non-Human Primates

Tost Subjects: liumans, Non-iluman

പി Mammala

The Proceedings of the Skylab Life Sciences Symposium, August 27-29, 1974, Life Sciences Payload Schoolele Vol. II, Report No. TM X-58151, JSC-09275, NASA-JSC. Comments from: R. Dunning, OMSE/MMS "Skylah: A Regioning" Lawrence F. Dietlein, M.D., NASA/ISC BIOMEDICINE (CANDIDATE FUTURE STUDIES) MEDICINE CY - 1980 (Early) - Life Sciences C₁ Mini Laboratory. Small (22.9 kg) laboratory assembled from Skylub & IMBLMS equipment plus a major Cardiovascular System in-dopth, noninvasive cardiovascular dynamics monitoring invasivo pressuro/volume/flow changes in early flight (animal) chemical analysis unit now under development. Demonstrate presence or absence of Gauer-Henry reflex Vostibular Function: Man only Electrolyte & Body Fluid Distribution Test: Man only Total body exercise regimen to maintain integrity of antigravity Oct. 1980 - Life Sciences Co Mini Laboratory. Small inhoratory (22.7 kg) as well as major muscle groups Assess role of veneus (capacitance) vessels in observed as described above (C_1) . Electrolyte & body fluid distribution, cardiovascular function, and deconditioning process vestibular function: man only Assess role of fatigue March 1981 - Medical Carry-on Category B Experiments Lab. Small Musculoskolotal System (42.3 kg) modular lab assembled from Skylab and IMBLMS equipment Absolute catabolic in-flight changes (bone, muscles) in animals Countermeasure evaluation: Fellow up results from US/ESRO Life Sciences Lab & Life Sciences Dietary Dedicated Lab Physical Vestibular function, electrolyte & body fluid distribution, and 7 Hormonal cardiovascular function: man only Plaid/Electrotytes - Demonstrate Gover-Henry reflex Aug. 1981 - Medical Carry-on Category B Experiments Lab. Small (12.3) kg modular lab assembled from Skylab & IMBLMS equipment items. Runal homodynamics in zuro-g Follow up results from US/ESRO Life Sciences Lab & Life Sciences Renal response to water/salt leads, dehydration in zero-g Dedicated Lab Rumoral interactions involved in above Vestibular function, electrolyte & body field distribution, and cardiovascular function: man only Feb. 1982 - Medical Category B Carry-on Experiment Lab. Small (42.3 kg) modular lab assumbled from Skylab & IMBLMS equipment items. Vostibular System - Role of altered cues: visual, kinosthetic, other sensory Follow up results from US/ESRO Life Sciences Lab & Life Sciences Dedicated Lab Effect of everhydration, dehydration and increased venous Vestibular function, electrolyte & body fluid distribution, and pressure on motion sickness threshold eardiovascular function: man only Predictive test for zero-µ space stelmess susceptibility Aug. 1982 - Life Sejences Category A Medical/Biological Carry-on Experiments Lab. Medium size laboratory module cluster (201 kg. (? parabolic flights) Basic studies regarding etiology 1. 44m3) capable of accomplishing a wide range of moderat research Role of one-g training in prevention areas of interest to moderate depth in a series of flights. Improved medications for prevention/control Test Specimen: Man BIOLOGY Aug. 1982 - Life Sciencos Category A Medical/Hiological Carry-on Experiments Lab. Medium size laboratory module cluster (201 kg) 1.44m³) capable of accomplishing a wide range of biological research arens of interest to moderate depth in a series of flights. Test Specimens: Small vertebrates, cells & tissues MAN/SYSTEMS INTEGRATION Feb. 1983 - Life Sciences Category A Man-System Integration Carry-on Experiment Lab. Modium size laboratory module cluster 187.7 kg, 0.85m³) capable of accomplishing all priority research areas of interest in MSI to moderate depth over a sories of flights. LIFE SUPPORT/PROTECTIVE SYSTEMS Aug. 1983 - Life Sciences Category & Life Support & Protective Systems Carry-on Exp. Lab. Medium suo laboratory module cluster (198 kg, 1.09m3) capable of accomplishing a wide variety of Life Support and Protective Systems tests of protetype and flight hardware components and subsystems as well as scientific and engineering principles.

Tost Subjects: Humans, Small Vertebrates, Cells & Tissues

Test Subjects: Humans, Non-Human Primates, Small Mammals,
Colls & Tissues

TIME-PHASED LIFE SCIENCES RESEARCH FOR CONSIDERATION ON 7-DAY DEDICATED LABORATORY

PRELIMINARY INTEGRATED LIFE SCIENCES PAYLOADS FOR SHUTTLE/SPACELAR THROUGH 1985, PREPARED FOR DR. WINTER, 7 FEBRUARY 1975

EFFECTS OF SPACE FLIGHT ON MAN

Evaluation of the Cauer-Henry reflex in large mammals

Animal studies of shifts in body fluid & blood distribution

Ituman input/output water balance studies with respect to cardiovascular performance

Anthropometric measures of cardiovascular fluid shifts

Testing of inflight space nauses countermeasures

Evaluate pru - and post-flight "space nauson" screening tests to determine predictive value

Hormonal & electrolyte assays to measure mineral & fluid balance

Follow-up studies in Skylab renal function observations

Studies on bone marrow suppression in weightlessmess

Evaluate the effectiveness of types of exercise maintaining cardiovascular and nuscular tono

Investor animals studies to measure factors controlling postflight cardiac output

SCIENTIFIC USES OF THE SPACE SHUTTLE, SPACE SCIENCE BOARD, NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCES, WASHINGTON, D.C., 1974

Burg.

BIOMEDICINE

Cardiovascular System

Experiments in both animats & humans needed:

- Peripheral blood flow (LBNP)
- Exercise effect on cardiovascular regulatory responses
- Study of body fluid compartment volumes
- Study possible strophy of cardiac & other muscles

Heaptration

- Study mechanical function of lungs in zoro-g
- Study pulmonary vascular resistan
- Study lung resistance to infection telliary transport, lymphatic drainago, phagocytic function)

Kidney & Metabolium

Aldosturone secretion Body electrolytes Insulin secretion Growth hormony sucretion Body fluid compartment volume measurement Bone formation in zero-g (hone repair in animals) Effect of zero-g on banal metabolic rate

Homatology Red blood cult mass measurement Bone marrow functional response to zero-g Blood granulocytic response to inflammatory stimuli

Neurology Study vestibular functions in man & animals Neurophysiological dysAmetion (righting rolloxes - cardiovascular) Norvous system development in animals in zuro-g clamonstrate dysfunction in 1-g)

Microbiology
Study of collular immunity functions relative to best resistance (specific immune response mentioring & record of best infections)

HOLOGY

imail vertebrate studies on the relationships of endocrine control of numeralian physiology Animal studies on the mechanisms involved in space muses

and vostibular adaptation to zoro-g

*Designated as "Research" in above source.

MOLOGS.

Physiological offects of zero-g on small mammals liebavioral patterns in zero-g Cellular and intracollular movement in zero-z Plant growth and development

MAN/SYSTEMS INTEGRATION

Evaluation of Advanced Design Concepts
Flight test of planetary sample return handling procedures

Test of teleoperator performance in simulated payload maintenance and servicing tasks

Simulation and training optimization studies for advanced man-machino taska

Experiment Support Equipment Design Evaluations Flight test of man-machine interface design criteria developed from Skylab results

MAN/SYSTEMS INTEGRATION

Maasuro decrements in performance Suciy interpersonal reaction patterns

Montal alorques and performance and aloop pattern relations blan/machine integration testing of teleoperator-remote manipulator system

LIFE SUPPORT TECHNOLOGY

LIFE SUPPORT/PROTECTIVE SYSTEMS

Evaluation of Advanced Design Concepts

Evaluation of gravity-influenced phenomena in regenerative (ife support systems Flight evaluation of advanced EVA life support and crow transportation concepts.

Component testing

Test Subjects: Humans, Non-Human Primates, Small Mammala, Colls & Tissues

Tost Subjects: Bumans, Non-Human Primates, Small Mammals, Colla & Tissucs, Plants

LIFE SCIENCES PAYLOAD SCHEDULE, R. DUNING, OMST/MMS

MEDICINE

Dec. 1980 - Life Sciences Dedicated Laboratory, Med I (Medical Emphasis Mission) Medicine: All Research Areas of Interest (RAI)

July 1981 - Life Sciences Dedicated Lab, Not II (Blology and Advanced Technology Mission)
Medicing: All Besourch Areas of Interest (BAI)

Jus. 1982 - Life Fotunces Builleated Lab, Med II (Biology and Advanced Technology Mission)

Modicine: All Immetric Areas of Interest (BAI)

The Proceedings of the Skylab Life Schaees Symposium, August 27-20, 4971, Vol. II, Report No. TM X-38151, JSC-09275, SASA-JSC. Commonts from "Skylab: A Bennmine" Lawrence F. Dietlein, M.D., SASA/ISC

BIOMEDICINE (CANDIDATE FUTURE STUDIES)

Cardiovascular System

- In-depth, nontheastro cardiomscular dynamics monitoring
- bysaire pressure/volume/flow changes in early flight (animal)
- Domaistrata prosonce or absence of theor-tionry raffex
- Total body exercise regimen in maintain broughly of antigravity as well as under muscle groups
- Assess tole of voices (espectance) vessels in observed decorditioning process
- Annuau role of failgue

Musculoskolotal System

- Absolute catabolic in-flight changes (hone, mesoles) in animals
 - Countermeasure evaluation:

Dictary Physical

? Hormohai

Finid/Electrolyten

- Demonstrate Cauer-Heavy reflex
- Ronal humorbnamics in rem-g
- Henry response to water/salt leads, dehydration in sern-p
- thenoral interactions involved in above

Vestituinr Systom

- Role of altered com: visual, kinesthetic, other sensory
- Effect of prophysication, thehydration and increased vocume pressure on motion stokness threshold
- Predictive test for zero-g space stekness susceptibility (Y parabolic flights)
- liante studios regarding ettology
- Hole of one-g training in provention
- . Improved multentions for prevention/control

MOLOGY

- Dec. 1980 Life Selencos Dedicated Laboratory, Mod I (Mudical Emphasia Mission)
 - Biology: Primaton, Small Vortebratos, and Culis & Tissues All Russurch Areas of Interest (RAI)
- July 1941 Life Sciences Dedicated Lab, Mod II (Biology and Advanced Teornology Mission)
- Biology: Primates, Small Vortubrates, Cells & Tissues, Piants, Invertebrates: All IIAI Jan. 1984 - Life Sciences Dedicated Lab, Mod II (Biology and Advanced
 - Technology Mission)
 Mology: Primatos, Small Verichastos, Cults & Tissuos, Plants,
 Invertabratos: All RAI

MAN/SYSTEMS INTROGRATION

- Dec. 1980 Lafo Soloncos Dedicated Laboratory, Mod I (Modical Emphasia Mission)
- lighavior: All RAT
- July 1981 Life Sciences Indicated Lab, Med II (Biology and Advanced Footmology Mission)
 Behavior: All RAI
 Jan. 1982 Life Sciences Buffested Lab, Med II (Biology and Advanced
- Jan. 1981 Life Sciences butteried Lab, Mod II (bloingy and Advanced Technology Magion) Isolarior: All IAI

LIFE SUPPORT/PROTECTIVE SYSTEMS

- July 1981 Life Sciences Dedicated Lab, Mod II (Biology and Advanced Technology Mission)
 - Life Support & Protective Systems: All RAI
- <u>Int. 1982</u> Life Sciences Bediented Lab, Mod B (Biology and Advanced Technology Mission) Life Support & Protective Systems; All RAi

Tout Subjects: Humans, Non-Human Primates, Small Mammals, Colls & Tissuce, Plants, Invertebrase Test Subjects: Humans, Non-Human Primates, Small Mammals, Cells & Tissues

TIME-PHASED LIFE SCIENCES RESEARCH FOR CONSIDERATION ON 30-DAY DEDICATED LABORATORY

for shuttle/Spacetab through 1988, Premared for Dr. Winter, T February 1976	Scientific Uses of the Space Shuttle, Space Science Stoard, National Research Council, National Academy of Sciences, Washington, D.C., 1974
FFECTS OF SPACE PLIGHT ON MAN	Momedicine
call mammal experiments to measure the absolute rela- carrite between length of exposure to weightlessmess and uid volume shifts mail mammal studies on sero-g rejated maculoskeletal	Cardiovancular System (Expts in both animals & bunana socied) Peripheral blood flow (LBNP) Exercise effect on cardiovascular regulatery respinsess Sudy of body fluid compartment volumes Sudy possible stroopy of cardiov
hang d	inepiration - Study mechanical function of lungs in zero-g
mail mammal studies on Erythropolesis flocts of reduced gravity on calcium loss from boses	 Study pulmonary vancular resistance Study lung resistance to infection (ciliary transport, lymphatic drainage, phagnoytic function)
ionitoring of input/output water balance to study cardio- ascular fluid shifts	Kithey 2 Mendadian - Albasterone, Insain, & growth bormone secretion - Rivo electrolysis & Suid compartment volume measurement - Roup formation is here-g (lone repair in animals)
valuation of in-flight space aickness countermeasures	- Effect of zero-g on basal mutabolic rate
n-flight hormonal and electrolyte nassys to measure singral and fluid balance	Red blood cell mans measurement Rone marrow functional response to sero-g
ollow-up audies on Skylab renal function observations	Blood granulocytic response to inflammatory stimuli Blody vestibular functions in man & animals
luman & animal studios on bono marrow suppression	 Nourophysiological dyshmotion (righting reflaxes - cardiovascular) Nervous system development in animals in zero-g
Cyalizate offectiveness of types of exercise in maintaining ardiovancular & muscular tone	(demonstrate dysfunction in 1-g) <u>Microbiology</u> - Study of cellular immusity functions relative to best resistance
evaluation of countermeasures for losses of minerals aring speceflight	(specific immuse response menturing 4 record of heat infections)
Stakuation of crow solection criteria (rafractory to atabolic billumness of spacellight) for prolonged missions	Facilobishogy - Study biological effects of HZE-particle for proof-of-principle) - Study molecular basis of sero-g perturbs ion of cell division (in vivo & in vitro cell isbelling)
NOTARY (Dunignated as "Hosearch" in above source)	BIOLOGY
namel audies on effects of weightlescapes on aging small vertebrate & invertebrate studies of cultular division & differentiation during spaceflight (valuation of biological rhythma during spaceflight (valuation of biological rhythma during spaceflight (valuation of biological rhythma during spaceflight (valuation of the cellular mechanisms of custrolling behavior (study of mechanisms controlling pentrophic responses in planta (valuate effects of weightlescapes on plant growth, devolugation and animal studies on mechanisms trealized in space names & resultables on mechanisms trealized in space names & resultables attendation to force of study of officets of reduced gravity on variablests reproductive processus, montrollens, particular, development, maturation, austrition & longovity Measure effects of reduced gravity on a brand range of animal behavior involving scenery, nearonnecular, and sourclogical performance	Cellular & Endocolar Hickory Stutics of the kinetics of cell growth & cell division in: plant & animal tissue cultures, bane narrow in vivo, shin in vivo, intestinal spitelium in vivo, repair rate of damaged skin & injured base marrow, embryonic development Genetic studies: cell division, chromasums replication Cellular & intrareditate movement in zero-g Animal Hinday Frysiological effects of zero-g on small mammala Marphogetic characteristics if simple metascans - protozoa - diatoms Small mammal post-main growth & development in zero-g: cardiac deconsitioning, mineral mutabolism, musculoskeletal development Effects of fructional g (variable centrifuge) Bohaviard patterns in zero-g Circadiac riptims Jent Hology Plant Growth & thevelopment: Arthidopsis, carrots, tobacco, sunflower-tissue miltures Gentropism of stem & root tissue pheform on ground in clinostan to mimic weightlinessess & varify in zero-g on variable centrifuge
MAN/SYSTEMS INTEGRATION Evaluation of Advanced Design Concepts Evaluation of Advanced Design Concepts Evaluation of Advanced Design Concepts Evaluation of Advanced Programs (from Cyring) in deploying, retrieving, & servicing satellites romate from the shuttle Touting of mulnimance & repair techniques and trois Simulation & training optimization studies for man-machine tasks Experiment Corport Engloment Design Systemations Flight text of man-machine interface design criteria developed from Skylab results Assessment of the safety, efficiency, & effectiveness of laboratory techniques & procedures is alto measurement of EVA per formance capabilities, validation of man-machine task allocation rules, & verification of EVA support hardware (tools, restraints, lights, etc.) acceptability	MAN/SYSTEMS INTERITATION Measure decrements in partormance Study interpersonal reaction settlems Mental stortess and performance is along pattern relations Man/machine integration testing of teleoperator-remote manipulator system
LIFE SUPPORT/PROTECTIVE SYSTEMS	LIFE SUPPORT TECHNOLOGY
Evaluation of Advanced Design Concepts Evaluation of time-dependent, gravity-influenced phonomena in regenerative life support systems	Companent to sting
as talkatas and the private talkaning	

Test Subjects: Ilumans, Non-Human Primates, Small Mammala, Vertebrates, Invertebrates, Cella & Tissues, Piants Test Subjects: Humans, Non-Ruman Primates, Small Mammals, Cells & Tissues, Plants

life Sciences Payland Schedule, E. Dendor, OMER/MAR	The Proceedings of the Stylab Life Sciences Symposium, August 27-29, L87 Wel. II, Royart Na. Thi N-55154, JSC-09275, NASA-JSC. Comments from "Skylab: A lagrange" Lawrence F. Dietleis, M.D., NASA-JSC.
MEDICINE	BIOMEDICINE (CANDIDATE FUTURE STUDIES)
July 1982 - Life Sciences RO-Day Dedicated Lab, Mod II (Mology/Advanced Technology Minates) Medicher All Rassurch Areas of Interest (RAI) Jap. 1982 - Life Sciences Dedicated Lab, Mod II (Biology/Advanced Technology Minaton) Sectioner: All RAI July 1982 - Life Sciences Dedicated Lab, Mod III (Biology/Technology Emphasia Minaton) Medicine: All RAI *First Bight of Life Sciences Rassarch Centrifuge	Cardiovascular System - In-depth, neninvasive cardiovascular dynamics mentioring - Investive presence or absence of Gauer-Henry relies - Demonstrate presence or absence of Gauer-Henry relies - Total body exercise regimes to maintain integrity of entigravity as well as major muscle groups - Assess role of venous (capacitance) vessels in observed deconditioning process - Assess role of fatigue Musculoakeletat System - Absolute castoolic in-Right changes (bone, muscles) in animals - Constermensure evaluation: Distary Physical - Hormonal Phid/Electrolytes - Demonstrate Gauer-Henry reflex - Renal hemodynamics in zero-g - Renal response to water-fael loads, dehydration in zero-g - Renal response to water-fael loads, dehydration in zero-g - Humoral interactions involved in above - Unificial Skylab results on longer Earth-orbital Hights - Validate Skylab results on longer Earth-orbital Hights - Validate Skylab results on longer Earth-orbital Hights - Role of altered costs: visual, kinesthetic, other sensory - Effect of overhydration, dehydration and increased venous - pressure on motion sickness threshold - Pradictive inst for surer-g space sickness susceptibility - (? parabolic Hights) - Basic studies regarding sticlogy - Role of one-g training in prevention - Limproved modications for prevention
	- minima monications for bleasures/control
DIOLOGY <u>July 1982</u> - Life Sciences 30-bay Duticated Lab, Mod II (Biology/Advanced Technology Mission) Biology: All RAI	
Jan. 1983 - Life Sciences Redicated Lab, Mod Π (Biology/Advanced Technology Mission) Biology: All RAI	
July 1983 - Life Sciences Dedicated Lab. Mod III (Biology/Technology Emphasis Mission)* Biology: 42 505.	
*Pirat P(; 100 temperature Research Contribuge	
•	
	1
MAN/SYSTEMS EXTEGRATION July 1982 - Life Sciences 30-Day Dedicated Lab., Med II (Diology/Advanced Technology Mission)	
Bohavior: All RAI Jan. 1063 - Life Sciences Dedicated Lab., Mod II (Biology/Advanced Technology Mission) Behavior: All RAI Behavior: All RAI	
July 1983 - Lafo Sciences Dedicated Lab, Mod III r Biology/Technology Emphasia Mission)* Bohavior: All IIAI	
*First Flight of Life Sciences Research Contribute	
tion compate /historycortily cyceptus	
LIFE SUPPORT/PHRYECTIVE SYSTEMS July 1993 - Life Sciences 30-lay Dedicated Lab, Mod II (Biology/Advanced Technology Milasion) Life Report 4 Protective Systems: All RAI Jan, 1993 - Life Sciences Dedicated Lab, Mod II (Biology/Advanced Technology Milasion) Technology Milasion	
Technology Missieti) Life Support & Protective Systems: All RA1 July 1993 - Life Sciences Dodicated Lab, Mod III (Diology/Technology Emphasis Mission)* Life Support & Protective Systems: All RA1	
*First Flight of Life Sciences Research Centrifuge	1

Tost Subjects: Humans, Non-Human Primates, Small Mammats, Cells & Tissues, Plants, hvertebrates

Test Subjects: Humans, Non-Human Primates, Small Mammals, Cells & Tiesses Baseline Life Sciences Research Requirements for Spacelab, Extracted From NASA/MSFC Report NAS8-30288, August 1974.

(General Dynamics Convair Report No. CASD-NAS-74-046).

Research Area Priorities for Biomedical and Biomedical Surrogate Missions

RESEARCH AREAS	PAYLOAD INTEGRATION TEAM-AIG . 72	STEERING COMMITTEE- JULY 72	HDQTS., JULY 1973	ARC, SEPT. 1973	SKYLAB	*VERTEBRATE	*CELLS & TISSUES
CARDIAC FUNCTION	1	1	2	1		CARDIAC FUNCTION	BIOCHEMICAL PROPERTIES
PULMONARY FUNCTION	2	2	3	2		PULMONARY FUNCTION	BIOPHYSICAL PROPERTIES
HEMODYNAMICS	3	3	4	3		HEMODYNAMICS	RADIATION EFFECTS
BLOOD MORPHOLOGY ELECTROLYTES ENZYMES HI ENDOCRINES GASES ORGANISMS LIMMUNOGLOBINS BPROTEINS CHEMISTRIES					e determined	BLOOD MORPHOLOGY ELECTROLYTES ENZYMES ENDOCRINES GASES ORGANISMS IMMUNOGLOBINS PROTEINS CHEMISTRIES	MORPHOLOGY
G.I. FUNCTIONS	4	6	-	5	то ве	G.I. FUNCTIONS	
EXCRETORY FUNCTIONS LO	5	7	4	4		EXCRETORY FUNCTIONS	
METABOLIC STUDIES	6	5	4	6		METABOLIC STUDIES	
MICROBIOLOGY STUDIES	6	-	5	6		MICROBIOLOGY STUDIES	• .
NEUROLOGICAL FUNCTIONS	7	8	1	7		NEUROLOGICAL FUNCTIONS	
VESTIBULAR FUNCTIONS	7	4	6	6		VESTIBULAR FUNCTIONS	
*PARALLEL BIOMEDICAL RESEARC	н овјест:	: IVES TO :	· STUDY BA	, SIC MECH	Hanisms (OF MAN'S ADAPTATION TO THE	SPACE ENVIRONMENT.

Basic Science Research Area for Vertebrate, Cell and Tissue, Plant and Invertebrate Missions

VERTEBRATES	CELLS & TISSUES	PLANTS	INVERTEBRATES
GROWTH	GROWTH '	GROWTH	GROWTH
DEVELOPMENT	DEVELOPMENT	DEVELOPMENT	DEVELOPMENT
REPRODUCTION	METABOLIC STUDIES	METABOLIC STUDIES	metabolic studies
EMBRYOGENESIS	HOST-PARASITE RELATIONS	BIOCHEMICAL PROPERTIES	BIOCHEMICAL PROPERTIES
SENESCENCE & AGING	GENETICS	MORPHOLOGY	MORPHOLOGY
GENETICS	RADIATION/HZE PARTICLE EFFECTS	EMBRYOGENESIS	EMBRYOGENESIS
RADIATION/HZE	PARTICLE EFFECTS	HOST-PARASITE RELATIONS	RADIATION/HZE PARTICLE EFFECTS
PARTICLE EFFECTS		Genetics	**************************************
	1	RADIATION/HZE PARTICLE EFFECTS	

Representative Plant Research Functions List

GROWTH & DEVELOPMENT

GROWTH RATE
SEEDING CELL ORGANIZATION
ROOT DEVELOPMENT
FLOWER SYMMETRY
LEAF SYMMETRY
POLLEN MATURATION
GERMINATION TIME
GEOTROPISM/PHOTOTROPISM
SEED MORPHOGENESIS
CYTOLOGIC STAINING
STOMAL OPENING

PHYSIOLOGY

CHLOROPLAST METABOLISM PHOTOSYNTHETIC ACTIVITY VIRAL IDENTIFICATION FUNGAL IDENTIFICATION

COMMON OPERATIONS

SPECIMEN STATUS OBSERVATION
AIR SAMPLING
MICROSCOPY
MASS MEASUREMENTS
BIOSAMPLING
OXYGEN MONITORING
CO₂ MONITORING
WATER VAPOR MONITORING
RADIATION MONITORING

BIOCHEMISTRY

TOTAL NITROGEN CARBOHYDRATE CONTENT WATER-MINERAL TRANSPORT PLANT HORMONE ASSAY PHYCOCYANIN PROTOPORPHYRINE PLANT ENZYME ASSAY INVERTASE ACTIVITY GEHYDROGENASE ACT. PEROXIDASE PLANT LIPIDS AMINO ACID ASSAY ISOTOPIC UPTAKE (C, Ca, N, P) STARCH GRANULE ASSAY ALKALOID SYNTHESIS CARBON DIOXIDE EVOLUTION OXYGEN UPDATE

Initial List of Equipment Items for Biomedical and Biological Areas

equipment (tems			SING F.P.E	,¹g	
equipment items	BIO- MEDICINE	SMALL VERTE- BRATES	Cells & Tissues	PLANT8	INVERTE BRATES
SPECIMEN ACQUISITION					
air particle sampler	X	×	×	x	x
ALCOHOL SWADS	X	x	X	x	X
ANESTHUTIZER, INVERTEBRATE	l i		ì		х
BIOBACKPACK, MICRO		X			
Blades, Surgical (25 PK) Chloral Hydrate	×	X X	X	×	x
CUFF, BLOOD PRESSURE	x	^	-		ļ
ELECTRODES, EEG, EXG, DISPOSABLE	x	х			1
FLOWMETER, DOPPLER, BLOOD	x	x	ļ	į .	i
FORCEPS, GILBERT		x	x	l x	x
FORCEP, NEEDLE, METZENBAUM	1	x	×		х
FORCEPS, SPLINTER	x	×	x	x	х
FORCEPS, TISSUE (RATTOOTH), MICHEL	ľ	×	x	x	X
HARNESS, ELECTROPHYSIOLOGY	х		[į.	
Harness, electrophysiology, micro	1	x	į	i	Į
KNIFE HOLDER, BARD PARKER		x	×	x	x
LANCETS (25/KTT)	X	х	1		1
LOOP, INOCULATING	X	х	X	X .	X
MEDIA, BLOOD AGAR, PLATED	x	X	X		X
MEDIA, EMB AGAR, PLATED	X	X	X	i	X
MEDIA, FLUID, EXP. SPECIFIC MEDIA, PHENYLETHYL ALCOHOL AGAR	X	X X	×	X	X
MEDIA, PHENYLETHYL ALCOHOL AGAR MEDIA, SOLID, EXP. SPECIFIC	x .	^	x	x	, x
MEDIA, TSA AGAR, PLATED	x	x	x		! : x
MICROSURGERY SET		x	x	x	x
NEEDLE, INOCULATING	x		×	1 · 🛣	X
NEEDLES, VACUTAINER, 21 GA., 26 GA.	x	x		ļ	
NEMBUTAL	1	x		1	j
ORGANISM TRANSFER/RESTRAINF CAPSULE		×	!		1
PIPETTES, OXFORD SAMPLER	x	l x	x	X	X
respirometer, strain gage	l x	x	1	ļ	
RETRACTOR, WEITLANER	Į) x	ļ	1	X
SCISSORS, BABY OPERATING	1	×	x	X	X
SCISSORS, MAYO-NOBEL, DISSECTION	1	X	×	X	X
SCISSORS, OPERATING		X	1	x	
SPIROMETER MOUTHPIECES	X				
SYRINGES, 1 CC (20/KIT) SYRINGE, BLOOD COLLECTING (EA)	X X	X	x	x	×
SYRINGE, VACUTAINER, PED SIZE (25/KIT)	x	ı î		1	
THERMISTOR, DEEP BODY TEMP.	Î	x			x
XDCR, VENOUS PRESSURE, IMPLANTABLE	1 ^	ŀ x			^
ZERO G RESTRAINING DEVICE, EQUIPMENT	x	x	×	x	x
SPECIMEN PREPARATION		:		,	!
ANIMAL DISSECTION BOARD, UNIVERSAL		x			1
CENTRIFUGE, MICROCHEMITAL/HCT	x	x	x	1	x
COUNTER, DIFFERENTIAL		x	x		х
COUNTER, TALLY	х	х	x	X	x
COUPLER, DOPPLER FLWMTR.	x	X			1
COUPLER, EEG	X x	X			
COUPLER, EMG	X	X]	1]
COUPLER, PRESSURE XDCR	X	X	1		X
COUPLER, STRAIN GAGE	X	X X			X
COUPLER, THERMISTOR COUPLER, VECTORCARDIOGRAM	x	x	ì		x
COVER SLIP (COUNTING CMBR)	x	x	x	x	x
CRITOSEAL	l â	x	x	1 "	Î
DISSECTION BOARD CLIPS (PACKAGE)	"	x	"		"
GAUZE, 2×2, SPONGES (200)	x	x	i x	1	x
GLOVE BOX		x	x	l x	×
HOMOGENIZER, .2 TO 50 ML	1	x	x	x	x
LYOPHILIZER, SPACE VACUUM (MANIFOLD)		x	x	x	x
MICROSCOPE, DESECTING		x	x	x	x
NEEDLES, ASSORTED SIZES	x	x	×	х	х
NEEDLES, SUTURE, ASSURTED SIZES	I	×			1
organism/specimen mass meas. Device	1	х	1	х	х
PIPETTES, OXFORD SAMPLER	X	х	×	X	X
RADIOBIOLOGICALS, INJECTABLE	_ x	х	1	х	x
SAMPLE PROCESSOR, AUTOMATIC, BLOOD	x	ļ x	1	1	1

Initial List of Equipment Items for Biomedical and Biological Areas, Cont'd

			USING F.P.E	.*8	
	BIO-	SMALL VERTE-	CELLS		INVERTE
EQUIPMENT ITEMS	MEDICINE	BRATES	T198UES	PLANTS	BRATES
SPECIMEN PREPARATION (CONT'D)					
SLIDES, MICHOSCOPE	X	X X	X	×	X X
slide stainer, automatic Squibbs (Plant Growth Arrester) (25/PK)	! * !	^	1 ^ 1	x	х
SQUIBB FIRING MECHANISM))		1 1	×	
BTAINS, ASSORTED, HISTOLOGICAL	1 1	x	x	×	х
TUTURE MATERIAL, MONOFILAMENT	1 1	x	! !	ļ	
BWABS, COTTON (4/TUBE)	X	X X	l X l	x	X
FEMPERATURE BLOCK 56 DEG.C FIMER, INTERVAL	X	x	×	x	X X
CUBES, MICROHOT, HEPARINIZED	x	x	ı x		×
TUBES, MICROHOT, PLAIN	×	×	ı x		x
WRIGHT BUFFER	X	x	x	J	x
Wright Stain) ×)	x) x		x
SPECIMEN STORAGE	1 1				
BAGS, PLASTIC, SEALABLE, LARGE	x	×	x	х	x
BAGB, PLASTIC, SEALABLE, SMALL	x	×	×	x	x
DRY STORAGE CONTAINER (ROOM TEMP)	×	X	<u> </u>	×	X
PIKATIVE, ETIKANOL	1	X	[×	- 1	X
Fixative, Formalin Fixative, Tissue, experiment specific	l x	X X	X	x i	X X
FIXATIVE, ZENKERS SOLUTION	l ŝ l	x	ÎÎ	^	x
FREEZER, CRYOGENIC (LN2) (OPTIONAL)	Î	x	î	x	x
FREEZER, LOW TEMPERATURE -80C	i x	x	×	x	x
FREEZER UNIT -10C	x	x	×	x	x
NCUBATOR, (MINI)	x	X	x	x	x
REFRIGERATOR	X	×	x	х `	x
PECIMEN VIALS	*	x	x	×	×
DATA ACQUISITION/STORAGE	1 1				
MAPTER, MICROSCOPE-CAMERA	X	x	x	X	x
CAMERA, 36 MM	X X	X	X	X I	X
CAMERA, POLOROD	X	X X	X	X	X X
CAMERA, VIDEO, COLOR CAMERA, VIDEOTAPE	l ŝ	X	x	. x	×
LOG BOOKS) x	x)	x	x
PAPE, MAGNETIC, INSTRUMENTATION	i x	x	x	x	x
PAPE RECORDER	1	x	(x !	х	x
ON BOARD SPECIAL ANALYSIS, REQ'D EQUIP.	1 1			i	•
NALYZER, BLOOD GAS, PH. PCG2, PG2	x	x			
COUNTER, COLONY, MANUAL	1 " 1	·	1 . 1	x	х
DISPLAY, CIT', ELECTROPHYSIOL.	x	x	!		X
ELECTROCARDIOGRAPH	x	x	!		
ABSIX (GLU, ALB, BLOOD, PII, KETONE)	f X	X	1 ;		
REMACYTOMETER	X	X	x		X
LEMOGLOBINOMETER	X	×			
METABOLIC GAS ANALYZER, CELLULAR METABOLIC GAS ANALYZER, PULMONARY) x	x	×	x	l
MICROSCOPE, COMPD	l â	x	x	x	х
SPIROMETER (PART OF METAL), ANALYZER)	1 2		"	^	
PR METER, CELLS/TISSUES MEDIA	"		×	x	
MAINTENANGE/CLEANUP	1				
DISINFECTING SWARS (PREPACKED TOWELS)	} x !	x	x ;	x	x
LINERS, DISSECTING BOARD (50/PKG)		x	^ ¦	•	x
LINERS, GLOVE BOX (50/PKG)	1	x	х ,	x	×
PORTABLE AIRFLOW WORK SURFACE	x	х	x	x	X
TEHILIZER, TOOL (BACTECINERATOR)	×	х	×	x	х
OWELS, DRY, DISPOSABLE	X	х	×	X	X
TOWELS, PREMOISTENED, ZEPHERAN CL	x	×	X	X	X
/ACUUM CLEANER (PART OF ECS AIR RETURN)	x	x x	X X	X X	X X
VASTE STORAGE CONTAINER ENVIRONMENTAL CONTROL/LIFE SUPPORT SYST		^		^	. ^
CR PACKAGE	<u> </u>		į		
AIR CIRCULATOR (BLOWER SYSTEM)]	x	×	x	x
COOLER, FLITE LOOP	1	х	X	x	×
FILTER, ACTIVATED CHARCOAL		x	x	x	x
FILTER UNIT, REPA		X	X	X	X
IEATER, FLUID LOOP		X	j X	X	X
OXYGEN MANIFOLD AND METERING SYSTEM	X	×	X	X	X X
DXYGEN SUPPLY, PRESSURIZED CYLINDERS	X X	X	x x	X X	X X
FHERMOCOUPLES FOLOING UNIT MODULE	*	^	! ^ !	^	^
ANIMAL WATERING DEVICE	i	×	,		
CAGE, SMALL VERTERRATES	- [â	, i		
CLINOSTAT		<u></u>	1	х	
COMMON CAGE MODULE		x	' x '	x	x
FEEDER, VERFEBRATE	1	X			
DAS MONITOR (CO2, O2)		x	x	x	x
HOLDING CHAMBER, CELLE/TISSUES		Ì	X		
IOLDING CHAMBER, INVERTEBRATES	1		×		x
LIOH CARTRIDGES] [х	!		×
PLANT WATERING SYSTEM, AUTO			_ '	x	
MEDIA, TESUE CULTURE WASTE MANAGEMENT SYSTEM, VERTEBRATES	į	v	×	į	
MARINE MARINEMENT STREET, ST. VENTERNATES	1	×	1 :		i

Initial List of Equipment Items for Candidate in MSI Experiments

	1	2	3	4	5	6	7	8	9	HUMEN 10	11	12	13	14	15	16	17	18	1
		1.		<u> </u>	,	•									-13	.0			ľ
REQUESED EQUIPMENT STEMS (E.1.'S)	Effects of Space Flight Environment on	Effects of Space Flight Environment on Paycho-	Cargo Handing Cargo Handing	Assembly, Deployment, Maintenance & Bepair Capabilities	Attached Teleoperator Manual Controllability	Free-Flying Teleoperator Romons Controllability	Effects of Space Filght Environment on Individual 6 Group Dynamics	- 9	Effectiveness of End Effector Designs	Off-Duty Activity & Facilities	Evaluation of Ministure Accelerometers	Feces Coll	ballight Determination of Bone Mound Content	Compact Respiratory Measurement System	Automated Clinical Chemical Analyzer	System to Preserve Biological Materials	Medical Aspirator	intravenous Fluid Administration Device	
ccolerometer	17.7	*************************************	×	13.75	×	H				-	×			-	7.5	*		-	† '
creler moter Coupler	1.		×		×	×	_				×	1		İ				İ	
ccommodation Stange Teater Irlock, EVA	*			1			*								×	×		١,	ļ
nomalascope	×	;	1			ļ			!		1			1					ĺ
udio Stereo Headast	×		,		:	:	×			Ì		1		j !				1	
udio Tone Source, Portable udiameter	×						×		i			1							1
age, Plantic, Permeable	1 ^	1	į.		1	•		•			1	1	t		×	×	ŀ	* *	İ
ench, Laminar Flow	1		× .	×				•									1	l i	1
Iobackpack, Micro	, y	ж	. x	×	; X	X	×	×		×	×	i				i		ĺ	ļ
amora, Cine amora, Still	1		' X	1 %		. X	x	×	. ×	X X	+	ļ		١.		1	ł	ĺ	ł
amers, Video B&W	1	x	×	×	× ×	×	x	×	ĸ	×		i		ł		×	×	×	1
amora, Video Color			x	* x	×	×	×	×	×	×		i		į.]	1	-	İ
amera Controller	×		×	1.5	, ,	٠	. ×	X	l i)	ł		İ	İ	×	×	×	
omputer, Digital onsole, Behavioral Measurements	×	x	•	^	^	•	×	•	^	x	•	1	1			1 "	•	"	1
onverter, A-D	×	X	×	x	×	×	×	×		×	×						-		1
rew Mobility Alds			×	, x				. *		X.	• ,	•		1		+			į
rew Hostrainte ats Control Unit, TV		×	×	X			×	×	:	X Y	×	×	. ×	. *	*		×	×	1
am Control Unit, TV am Managament System, Plotter & Control Module	x	x	×	×	×	×	×	×	x	×	x	, x	×	×	×				+
isplay/Keybeard, Portable			×	, x	×	, ж	. ×		,			+	;		.	, ×		1	į
ynamometer, Grip	1	x					х			:	L					:			÷
CG Coupler	×	×	×	×	×	×	×	×		×	×				į				1
EG Coupler Inctrophysiology Consolo] . î	*	*	x	x	×	â	x		×	ŝ								
lectrophysiology Display	* ×	x	. x	` x	×	· x	` - 3	* *	!	. x	×			1	•	•	:	:	!
loctrophysiology Monitor	×	×	X	2	×	X	λ	×		Α.	X				1				İ
loctrophysiology Roceiver Liters, Vidoo	×		X X	* *	*	*	A .	A X		X	. *					×	×	· x	
licker Fusion Apparatus	* N			•	•		x			•	1		•	•	•		•	:	1
as Supply, Assorted									I						ĸ	×			
unorator Signal	l x		*		×	*		x			×							İ	
arness, Small Wire it, Behavloral Monsurements I	x	, x				. "	. <u>.</u>		ŧ :	٠ ٪	, "		•	1	i	t		ļ	1
ti, Behavioral Measurements II	x	x					*			x								1	
imb Beard, Motor or Manual	×						, ×			ı							.,		
ng Books	1	1				٠.		į.			•	i			1	i *	. х	×	,
lanipulator, Henone leters, Assortod	×	×	· ×	×	, â	×	. x	' x	x	8	×	×	x	x	х	×		ļ	
Herophone	N.	x	1				×		ĺ	×						:		1	
tirror, itevolving Herne Mount - Commutator	, x		,	, x		_	, ×	X							• -	_x	. x	. x	•
lontior, Video			×	x	×	X.	×	×	x	3									
rthomter	× ×		1				×	1							•		:		
scillator, VDC		. *	, S	, ×	N	N			L	. × .	х		•		•	:			i
sciiloscopo typor, Recordiny		Ì.	1 -		١.			!	١.	.	×	1 _	i .	×			1	•	
mari ingertum	Ţ	1	X X	×	, ×	X 3	×	X	*	×	×	3	`	,]	1		
eghatril, Pariling		x	1 ~	1			,	1				1		<u> </u>		1	ļ	t	l
eghiaril, Binta Ana		` x	1	-	1	'	×	1	ļ										
erceptual Motor Perf. Tester exitum Estimation Control		X					X	}	İ										
ower Supply	ĺ		×	×) x	į x	×	×	×							, х		, x	
sychomotor Performance Console	1	×	į	•	1	ì	*	Ī	1										
sychomotor Rotating Disks adigiton Wasto System	1	*	1			i	x		i				i			!		,	
amation waste System ecolyor, EXO	x	i2	×		N.	×	×	×	İ	, x	. x	1	1				.	. *	
ecordor, Tapa, Voice	1 🛈	-		·	1 ~		×	1	ļ	* *	7 -		ĭ	1		-			
com, Privato		i	i	i	!	İ	*			×	i	i							
menrs, Assorted gnal Conditioners	×	X	· ×	×	×	×				. ×	X								
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undiness Tromor Apparatus	Ì	, ,	į	1		1	х	i		i		i							
orilizor, Autociavo	1	1	;	1.	1	i .	Í]				!	_		×	×		X	
orago, Gunoral apo, Video	*	, ×		, ×	×	×	X		! *	, ×	×	-+ K		ı. ×	, x	, k	1 X	. x	. +
apo, rasec argut, lamielt filing App.		1	1 ^	•	1	}	X			. 1	1					. "	-		
ankhuard, Force/Torque	"	×	1		I		x	1		Ì		!		1					
unkleard, Malat./Grown C.	+ .	*	1	•		i	*	ł		-	. .	1		+	•	+	1		
askboard, Position Repro. askboard, Rosp. Orientation	1	7. 7.					X	1	į		1	1			:				
askboard, Visual Roset, Time		×		!	!]	*		1	į.	1	1		i i	1				
imor, Event					1		1	L		1 .		. 	k.	į		}	1		
imor, Integral Equip.	_		x	×	-	1	Ţ	_	1		1	İ		ì		:	:		
ision Toster Ision Toster, Howard Dolman	X X		-			1	X	I				į		:			1		
felon Tester, Amer. Optical	Цŝ	_1	. [. !		1	, î	1	1	L.		<u> </u>		į.		į	4	i	
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xperiment Specific Equipment	1	×		1		×		j		1	*	*	×	· *		1			

Initial List of Equipment Items for the LSPS Experiment Categories

	 , , ,	2		4 7	EXPN	MENT	CATEG	ORIES	1 0	10	11	12
			E	-		<u> </u>		-8-				
EQUIPMENT ITEMS	Waler Re-	Name of	Protect Clothing a Sette	00 00 00 00 00 00 00 00 00 00 00 00 00	Cooling Systems	Atmos- phere Seroly	Atmos- phere Control	Trace Contain Control	EVA Sect Bicarck	Food & Peeding	O ₂ Regense	Whole Body
Air Lock - EVA			. 3									
Analyzer, Atomic Absorption Spectrophotometer	[-	.2	i i				×	<u> </u>	×	1	į
Analyzer, Infrared Absorption			×	×		_						.
Analyzer, General Spectrophotometer Analyzer, Micro-organism, Automatic I.D.	- * -	. ×	.	×		X	#			×	X.	
Analyzer, Conductivity								···-		·		ŀ
Atmospheric Sampling Manifold System				×		x	×	×			*	1.
Badree, Radiation, Standard Film								- X				1.
Page, Permeable Plastic Bicycle Ergometer	 	X	x -					 		 	├	
Bottles, Cells and Tiesuns	1	1			. ж.				1	<u> </u>	1	×
Camera, Cine												L.x.
Camera, Still Camera, Video, Black and White				.					 	ļ —		¥
Camera, Video, Color		×	T						- x	†	 	L.X.
Chemicals			_	X				X			×	7
Compactor, Solida Computer, Digital	 	<u> </u>		}- 		}- <u>-</u>			<u> </u>	×	├	·
Cooler, Thermoelectric	<u> </u>	_ *	<u>x</u>	_×	× .	<u> </u>	ж	×	×	}	<u>×</u> .	×
Counter, Colony, Manual	Т.											
Crew Mobility Aids	-		X		 				X			_×.
Crew Restraints Data Management Buses	*	ł	<u>*</u>	× -	x	- x	<u>×</u>		-X		ж.	ļ, " X
Data Management Plotter/Printer		×	1,	x	×	x	<u>x</u> .	×		1	- *	* ×
Data Management Control Station	×	Ļ <u> </u>	1 3	×	X	×	X	_ × _	×	Ţ	Z.	<u>, x</u>
Data Management Remote Instrumentation Modules Data Management Wide Rand & TV Unit	X X	ļ	-	X	$\frac{x}{x}$	- × -	×	<u>×</u>	 	 	×	ļ
Developer, Film	1	.	1	 -		- ^-	 _ *	×	<u>}</u> -	1	} *	1 .
Display - Kayboard		1	<u> </u>	×	*	×	×	×	1 -	1	×	×
Electrometer	ļ <u>. </u>	-	 -	<u> </u>	ļ	x	<u> </u>	X		<u> </u>	×	<u> </u>
Foeder, Liquid, Automatic	×	×	x	· · - · -	f ·	×	×	 	- x		┧──	×
Flowmeter Couplers	×	×	×	<u> </u>		×	† -Ç		- x -	×	 	×
Filters, Chemical	×	×] _	×		ļ	ļ	ļ	1	1	, x	×
Frig. (Refrigorator) Gas Analyzor, CO2	, x	X	ŧ	1 .		ŧ	x	١.	1	*	1 -	×
Gas Analyzor, Gas Chrompugraph	×	<u> </u>	×	X		*×	×	X	×	+ x	*	
Gas Analyzer, Mass Spectrometer, Research		× .	1	- ×	İ	×	x	X	1 "	x	_ x_	
Gas Analyzer, Mass Spectrometer, Special Gas Analyzer, O2	-×	-X	} = -	<u> -×</u>		X	×	×	4	1	↓. ×.	ļ
Gas Analyzor, Relative Humidity	 -		¥			ļ		<u>x</u> -	. ×	· ·	x	}
Gas Supply	{ x	×	1	×	_	×	X	×	\perp	_ ×	×	×
Gas Metering & Calibration Unit	ļ <u>.</u>	 -		×	ļ <u>.</u>	×	x	, ×		1	×	1
Holding Unit, Colla/Tissues Indicator, Atmospheric O2	 × -	<u>×</u>	┧──	╆┈┈	 	∤	7	×	+ .	1	1	*
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Kit, Clean-up	×	- <u>×</u>	×	. ×	×	ļ×	<u>×</u> .	_ж	×	, ×		×
Kit, Microbiology Kit, General Tool	- x	×	×	- } - x -−	- x	* · ·	×		+*	1 × -	×	×
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Storage, General Storage, Film	- ×		+	<u>x</u>	*	x	×	×	+ .	1	×	×
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TYPICAL SPACELAB EXPERIMENT REQUIREMENTS

Prepared by NASA Ames Research Center

July 1975

BASELINE MINILAB PACKAGE FOR HUMAN VESTIBULAR EXPERIMENTS

OTOLITH FUNCTION EXPERIMENTS

- I. Vestibulo-Spinal Reflex Examination of otolith-originating reflex during OG habituation by measuring EMG response in gastrocnemics muscle resulting from unexpected acceleration in head to foot detection.
- II.. Linear Acceleration Threshold Examination of sensitivity changes in otolith input channels during habituation to OG.
- III. H-Reflex Examination of otolith modulation of motoneuron excitability during habituation to OG and in response to sinusoidal head to foot acceleration.

VISUAL/VESTIBULAR EXPERIMENTS

- IV. Visual Accommodation Determine status of otolith system by monitoring changes in visual accommodation during habituation to OG (otolith-accommodation reflex).
- V. Tilt Illusion Examine effects of habituation to OG on illusions of tilt produced by random pattern rotating in frontal plane (illusion normally constrained by IG otolith input).
- VI. Linear Vection Threshold Examine sensitivity to illusion of linear acceleration in X, Y, and Z directions produced by moving visual stimulation of peripheral visual fields during OG.

BASELINE MINILAB PACKAGE FOR HUMAN VESTIBULAR EXPERIMENTS — 7-DAY & 30-DAY

		1	ith Funct		1	sual/Vestil	
		E	xperimen T	ts	ļ	Experimen	ts
		Vestibulo-Spinal Reflex	Linear Acceleration Threshold	H-Reflex	Visual Accommodation	Tilt Illusion	Linear Vection Threshold
	Function	.I.	11	Ħ	IV.	,	VI.
1a.	Otolith Stimulation — Linear Acceleration in X		x				
1b.	Otolith Stimulation — Linear Acceleration in Y	ı	x				
1c.	Otolith Stimulation — Linear Acceleration in Z	x	x	x			
2a.	Visual Stimulation — Axially Rotating Display					x	
2b.	Visual Stimulation — Peripheral Linearly Moving Display						x
3.	H-Reflex Stimulation			X			
4a.	Response Measurement — Visual Accommodation				X		
4b.	Response Measurement — EMG	x		X			
4c.	Response Measurement - Subjective		x			x	x
5.	Data Handling	x	x	x	x	x	ж
6.	Experiment Sequencing and Control	X	х	x	X	х	x
7.	Space Sickness Episode Documentation	х	Х	x	x	х	Χ̈́

112 115 116 22 22 25 44 46		
Otolith Stimulation — Linear Acceleration in X Otolith Stimulation — Linear Acceleration in Y Otolith Stimulation — Linear Acceleration in Z Visual Stimulation — Axially Rotating Display Visual Stimulation — Peripheral Linearly Moving Display H-Reflex Stimulation Response Measurement — Visual Accommodation Response Measurement — EMGe Response Measurement — Subjective Data Handling Experiment Sequencing and Control Space Sickness Episode Documentation Other	Function	
× ×	A. B.	Linear acceleration sled as per ERNO Linear acceleration sled with chair
*		tilted for acceleration head to foot
	c.	Large frontal display field with random
×		pattern rotating around subjects line of sight
	D.	Viewing box with random figure display
×	İ	moving in X, Y, or Z direction presented
·		to peripheral visual fields
×	E.	Electric stimulator (Grass S-4)
×	F.	Surface stimulating electrodes
×	G.	Hartinger coincidence refractometer
×	н.	EMG electrodes
×	I.	Response lever (analog signal)
X	J.	Signal conditioners
<u> </u>	K.	Analog time recorder (76 nan.)
× .	L.	Voice recorder
<u> </u>	M.	Log book
×	N.	Preliminary data analysis logic
×	0.	Chart recorder — 2 + Chan.
×	P.	Digital result display On-line control logic for stimuli
×	Q.	Control logic for sequencing
- x 	S.	Space sickness questionnaire
	T.	Fixed chair with bite board (may be
×	••	linear acceleration chair in fixed mode)
4	U.	Helmet with blindfold and/or tri-axial
1	1	accelerometers

MINIMAL EXPERIMENT PACKAGE FOR A RESTRAINED PRIMATE

				7		Typic	eal S	pacel	lab E	xperim	ents
Essential Apparatus and Procedures			/	ڔڠۣ		Τ,	/g/	/8	/	a	/ /s/ /
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Monkey Pod and ECS	х	x	x	x	x	х	х	x	x	х	
Analog Recording	x	x		x	0	ł	х	x	x		
Food & Water Intake Urine Sample		X	X X	0	X X	X X	x		00		
Urine Volume	x	x	x	0	x	X		Ì	x		
EKG	x			x					x		
EOG								x			
Mass Spectrometer					x	ļ					
Fecal Collection					x	x	x				
Body Temperature				X	x						
EEG				x				х			
Blood Samples	x		X	0		0			Х		
LBNP	X										
Biotelemetry	X	X		X			X	X			
X-Ray, T.V., and Digital Recorders							0			Х	ļ
"Minimum" Exposure - 2 Days	Х	X	X				X		.,	X	
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			Rei	Ambient Recording	Food & Water Intake	Fecal Collection	Urine, Rate, Vol., Sample	Respiratory Gas Analysis Blood Samnles	Intravenous Injection	Heart Rate	Blood Pressure	Cardiac Output	Cardiovascular Challenge	Body Temperature	Gastrointestinal Activity	Acceleration Threshold	Otolith Activity	Blood Flow Distribution	Heart Size	Chyme Distribution	Food Label	Blood Flow Rates	Response Lever	
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Food & Water Management Temperature Implant × × Flowmeter × × × × × Urine Collection Venous Catheter Equipment × × MIcrospheres × Proof Record × × nolaviosory & × × Nass Spec XX CARDIOVASCULAR × × ECS/Monttor Record Hotelenetry × Monkey Pod × XX × \bowtie × × XXX × ×× × Urine, Rate, Vol., Sample Respiratory Gas Analysis Cardiovascular Challenge Functions Gastrointestinal Activity Blood Flow Distribution Intravenous Injection Food & Water Intake Alteration Threshold Ambient Recording Chyme Distribution Retrained Primate Body Temperature Blood Flow Rates Fecal Collection Blood Pressure Response Lever Otolith Activity Blood Samples Cardiac Output Heart Rate Food Label Heart Size

CARDIOVASCULAR

				7		1	Equip	ment
Functions	A Poor	Hear Shelding	Ech. Implant	Uni dom	The Cathors	/	Tilleter /	////
Blood Pressure		x						
Monkey Pod and ECS	x							
Analog Recording		x	x					
Food and Water Intake								
Urine Sampling								
Urine Volume								
EKS		x		x				
EOG		j .						
Mass Spectrometry			i					
Fecal Collection								
Body Temperature			;					
EEG								
Blood Samples			,		X		x	
LBNP						x		
Biotelemetry		x						
X-Ray/T.V. Digital								
Cardiac Output			x					
	<u></u>			L				

MINIMAL EXPERIMENT PACKAGE CONCEPT FOR SMALL ANIMAL RESEARCH

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Animal			9/2											2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2	8/£/ 5
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Animal Cage	X	x	x	x	X	X	X	x	X	X	I	!!	X	X	· · · · · · · · · · · · · · · · · · ·
ECS	X	X	X	X	$ \mathbf{x} $	X	X	X	X	\mathbf{X}	X	X	Х	\mathbf{x}	
Urine Elimination		X		X	$ \mathbf{x} $		X		X	X					
Urine Collection	X		X]			\mathbf{x}			X	X		Ì	
Fecal Elimination		\mathbf{x}		X	X		X		X	X					
Fecal Collection	\mathbf{x}	X						х			X	X			
Urine-Fecal Separation	$ \mathbf{x} $		X	ŀ								X			
Volume/Amt. Measurement	\mathbf{x}		\mathbf{x}				!	Х			X	X			
Food & Water Intake	X		X	Х							X	X	X		
Respiration Collection			X								X	X			
Urine/Fecal Preservation	\mathbf{x}		X					\mathbf{x}			X	X			
Drug or Microbe Injection		X			\mathbf{x}						x			x	
Radioisotope Present	\mathbf{x}			\mathbf{x}							\mathbf{x}	?			
Radioisotope Counting				\mathbf{x}							\mathbf{x}	?			
T. V. Monitor			\mathbf{x}			\mathbf{x}						\mathbf{x}	\mathbf{x}	\mathbf{x}	
Body Temperature	;					-					?	X	X	1	
Biotelemetry		1									1	X		\mathbf{x}]
Photography	\mathbf{x}	\mathbf{x}	$ \mathbf{x} $			X				X		?	1	X	
Mass Determination	\mathbf{x}					?		\mathbf{x}		X	\mathbf{x}	X	F	X	
Activity	О		О		1				0	1	•	x		X	j
Analog Recording	x			\mathbf{x}				\mathbf{x}	Ī			x	1	X	
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MINIMAL EXPERIMENT PACKAGE CONCEPT FOR SMALL ANIMAL RESEARCH

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	runction	/å		\$ [*] /2	\$ ⁷ \$		\$\\\ 5			E/.5	§ 		0 X			\$
1.	Animal Holding & ECS	X	x	X	x	x	\mathbf{x}	x	X	$ \mathbf{X} $	x	X	x	x	x	
2.	Food & Water Intake	X			<u> </u>					X	i	X	х			
3.	Biological Samples	X	X	l	X	X		X	X			X		X		
4.	Remote Monitoring	O		X			X		О	О	О		X	X	X	
5.	Surgery	X	X	X				X	X	X	\mathbf{X}	X		?	X	
6.	Sample Processing															
1	6a. Chemical	О		X	X				X			X	?		0	·
	6b. Histological		0	0	 	X	?	X	X	X	X	X		O	X	
	6c. Microbiol./Culture					X										
	6d. 'Fixing'' (Freezer,	X	X	X	X		?	X	X	X	X	X	\mathbf{x}	\mathbf{x}	X	
	Chem., Fixative)				•											
7.	Radioisotope Drug Study	X	x	ţ	X	x						\mathbf{x}	?		X	}
8.	Control Animal	0	0	0	0	o	0		О	О	О	0	О	0	0	
	Centrifugation															
9.	"Minimum" Effective															
	Exposure- 7da	X	Х	x	x	\mathbf{x}	x	\mathbf{x}	x	x	\mathbf{x}		\mathbf{x}		X	
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MINIMAL EXPERIMENT PACKAGE CONCEPT FOR SMALL ANIMAL RESEARCH CONCEPT

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X — Required O — Desirable				2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	2/3/3/3/3/3/3/3/3/3/3/3/3/3/3/3/3/3/3/3			2 / 4 2 / 4 2 / 4 2 / 4 2 / 4 3 / 4	\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\						\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \
Biological Samples	/s								\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\			0/Q 3/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2	\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$
Respiration Samples			'	x							x				
Urine Sample	X		X					\mathbf{x}			\mathbf{x}	х			
Fecal Sample	X		X					X	. 1		X	X			
Freezer Preservation	X							X			X	X			
Chemical Preservation			X			l		X							
Blood Sample			X		\mathbf{X}			X			?	?			
Centrifugation			X		\mathbf{x}			x			?	?			
Refrig/Freezer			X			!		x		:	?	?			
Tissue Samples (Surgery)	X	\mathbf{x}	X			X		x	X	X	\mathbf{x}	?	Х	X	
Fixation		X	X				X	Х	X	X	X	?	X	X	
Sectioning		X	X				X	Х	X	X	X		X	X	
Embedding		X	X				X		X	X	X		X	X	
Histology		X	X		X		X		X	X	X		X	X	
Homogenization	О		X					X	X		X	?		X.	
Chemical Determination	0		X					X	X		X			X	
Refrig-Freezer	X	X	X					X	X		X	\mathbf{X}		X	
Microbiol. Culture		ļ.		\mathbf{X}									ļ		
Tissue Culture				X											
Mass Determination		1	X				X	X	X	\mathbf{x}	\mathbf{X}	X	X	X	
X-Ray or Bone Densitometry	X	ł													
Electron Microscope		1	О				O	О	0	1	0		0	0	!
Photography		X			ł	X	X	X		\mathbf{X}	X	?	X	X	
Isotope Counting	0		X	X	X						x				
Mass Spectrometer	?										X	X			
Spectroscopy	0		X					X			X	X	<u> </u>	1	

Life Sciences Research Requirements

The following tables represent a condensation of information given in the input data relative to establishing the research requirements for a life sciences space program. The tables are organized into the four main categories: Biomedicine, Biology, Life Support/Protective Systems and Man Systems Integration. These are further subdivided into functional areas and specific research topics. Specific research functions and/or measurements are described. Finally, descriptive data used to establish the priority determinations, in most cases excerpted from the data sources, are presented. The superscript numeral following each entry refers to a citation given in the following table of references.

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	RESEARCH DISCIPLINE	FUNCTIONS/MEASUREMENTS REQUIRED	PRIORITY DETERMINANTS
	BIOMEDICINE		
	Cardiovascular System		•
	Altered vascular flow, volume & pressure rela- tionships in zero-gravity.	Pulmonary capillary blood volume Pulmonary capillary blood flow Venous capacitance Venous compliance	Space flight furnishes an environment for cardiovascular study which can be produced in no other way. It is difficult to imagine that increased understanding of cardiovascular function and control mechanisms, as they are altered in weightlessness, will not in the future become relevant to the cardiovascular problems that face us on earth. I
		Arterial flow in limbs Body fluid component volumes - total body water volume - extracellular volume	Skylab studies have clearly shown that changes in fluid volume distribution during the first few hours of flight creates profound alterations in cardiovascular functions which in turn, impair orthostatic mechanisms to a marked degree as early as four or five days after entering the weightless environment. ²
		- plasma volume Renal blood flow	It should be noted in all crewmen there was an increase in compliance that required 10 days or more to reach a maximum. ³
	Demonstrate presence or absence of Gauer- Henry-Reflex.	Intrathorpeic blood volume ADH Renin	The Gauer-Henry reflex has yet to be demonstrated. This will not be easy to demonstrate in man, since the critical time-period to be investigated is thought to coincide with the early operationally exacting first day of the mission. ⁴
•		Angiotensin Aldesterone Catecholamines Water excretion Sodium excretion Plasma volume	The first two to three days of each mission were spent in the activation of the orbital workshop. ⁵
	Cardiovascular regula- tory responses to exercise in zero grave;	Electrocardiogram/vector- cardiogram - pulse raw and rhythm	The increased quantity and quality of exercise available to the crew was important in maintaining crew health of Skylab 4. 6
	(Man)	- cardiac axis Echocardiogram - stroke volume - cardiac output - cardiac compliance Systolic blood pressure Diastolic blood pressure - pulse pressure - mean arterial pressure Calibrated exercise level	Future research efforts should focus on optimum methods of exercise with respect to crew time and crew acceptance, inter- relationship of musculoskeletal fitness with cardiovascular fitness, and design of practical, efficient, total body exercisers. 7

FUNCTIONS/MEASUREMENTS RESEARCH DISCIPLINE REQUIRED PRIORITY DETERMINANTS BIOMEDICINE Cardiovascular System (Cont'd) Invasive studies on non-human primates. Changed relative thips in the anatomical distribution of blood volume and extravascular fluids, altered patterns of blood flow, and - Altered vascular flow Intracranial pressure volume and pressure Brain blood flow reduced total co-culating blood volume induced by the weightless environment are offered as partial explanations for the changes in cardiovascular responses to lower body negative pressure. 8 relationship in zero-Intracardiac catheterization gravity Coronary flow Animal maintenance These finding, have, in a predictable fashion, opened new questions which will direct future ground-based and in flight researches -Animal restraints particularly in the area of cardiovascular electro-hemodynamic studies for the Shuttle era. 9 Electrocardiogram/ vectorcardiogram - Demonstrate absence Histological preparation (postor presence of myomission) cardial degeneration resulting from zero-g exposure Pulmonary System The effects of gravity are so profound in altering the distribution of blood and gas within the lungs that many problems in basic VC. Vital capacity Altered pulmonary pulmonary physiology can be studied more effectively under weightlessness than in a normal gravitational field. One of the divi-Forced vital capacity volume/flow relation-FVC dends of space flight will be the opportunity to carry out experiments on the lungs that are impossible on Earth. 10 ships in zero-g FEV-1 Forced expiratory volume - one second No untoward physiological responses have been noted that would proclude longer duration space flights, but more research is CVClosing volume required in order to understand the mechanisms involved in the observed responses. 11 MEFR Maximum expiratory flow rate MMRF Maximum midexpiratory flow rate TLC Total lung capacity Residual volume Pulmonary capillary blood volume Pulmonary capillary blood flow

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LIFE SCIENCES SPACE RESEARCH REQUIREMENT

RESEARCH DISCIPLINE	FUNCTIONS/MEASUREMENTS REQUIRED	PRIORITY DETERMINANTS
BIOMEDICINE		
Musculoskeletal System Derangement basis and	Calibrated exercise level O ₂ consumption CO ₂ production M ^t e volume	bone loss definitely occurs under zero-g conditions. It is certain that this loss continues for at least sixty days, and it is almost certain that it continues for as long as 84 days. There has been no evidence that this phenomenon shows the type of adaptation to zero-g which has been exhibited in the other systems which have been the subject of this symposium. 12
zero-gravity - exercise effect upon musculoskeletal derangement	Bouy temperature ECG/VCG Systolic blood pressure Diastolic blood pressure Muscle strength	Finally, these observations may have significance for Earth medicine. In reminding us of the deleterious effects of disuse on bon mass, they reemphasize the importance of direct physical longitudinal stress (weight bearing) to the integrity of bone. In researce on osteoporosis, greater attention than heretofore might be given to this factor for the possible value of increased weight-bearing stress as a deterrent to or even as aid to correction of this extremely prevalent bone disorder. 13
oerange ment	Muscle mass Muscle reflexes Muscle potential *Bone mineral measurement *One-g readaptation time Anthropometric measurements	It would seem advisable in any case to search for means by which an astronaut in space might not only maintain his leg muscle mass, but also exercise his postural equilibrium systems. 14
- diet and pharma- cological control of musculoskeletal dorangement	*Post-mission Food/fluid input records Continuous 24-hr urine collection Total fecal collection Vomitus collection Storage of urine, feces, vomitus for analysis of: - urine & fecal calcium - " phosphate - " " nitrogen - " magnesium - " potassium - " sodium - urine-hydroxyproline - anthropometric measurements Premedication Plasma thyroxin level	Daily in-flight personal exercise regimens coupled with appropriate dietary intake and programed adequate sleep, work and recreation periods essential for maintaining crew health and well-being. ¹⁵ the continued high values for urine calcium through the entire length of the Skylab 4 study gives us no reason to believe that any kind of adaptation occurred during the 84 days of that mission. ¹⁶

LIFE SCIENCES SPACE RESEARCH REQUIREMENT

	FUNCTIONS/MEASUREMENTS	
RESEARCH DISCIPLINE	REQUIRED	PRIORITY DETERMINANTS
BIOMEDICINE		
Musculoskoletal System (Cont'd)		•
invasive studies on animais	·	
 absolute catabolic effects of zero-g on the musculoskeletal system 	Restrained experimental animals Unrestrained control animals Animal maintenance Physiological monitoring (implanted) Food/fluid intake measurements Urine & fecal collection & storage Blood sample collection & storage Histological preparations of: - muscle tissue - bone - bone marrow	Clearly, man is not vegetating in space, but is actually doing his utmost to maintain a high level of physical fitness and performance. Thus the absolute detrimental effects of null gravity will, in most cases, have to be determined in subhuman surrogates. 17
Basis and Control of Blochemical Reactions to Stresses in Space Environment	Time related record of crew nu- irition and exposure to stress and exercise. Radionuclide body compartment	However, taking in overview of the program as a whole, two outstanding features have emerged. First, Man can adapt to, and live in, the zero-gravity space environment for extended periods of time. But second, and therefore above all, none of the measured changes so far seen in missions extending up to 84 days have proved irreversible after return to Earth. ¹⁸
Fluid & electrolyte balance	studies: - total body water - extracellular volume - plasma volume	Venous compliance changes were demonstrated which, with blood volume changes, should provide an initial and primary point of departure for investigation of the complete response to lower body negative pressure. Time course of the compliance changes should be considered by mission planners. Shuttle reentry, for example, will fall within the zone of increased sensitivity to orthostatic stress. ¹⁹
Calcium regulation		
	Obtain fractionated urine samples	By the time of the earliest in-flight measurement on mission day 3, all crewmen had lost more than two liters of extravascular
Adrenal function	and plasma and serum samples for on-board and/or delayed	fluid from the calf and thigh. The pully faces, the "bird legs" effect, the engorgement of upper body veirs, and the reduced volume of lower body veins were all documented with photographs. ²⁰
Food utilization	analysis.	

	FUNCTIONS/MEASUREMENTS	
RESEARCH DISCIPLINE	REQUIRED	PRIORITY DETERMINANTS
BIOMEDICINE		
Basis and Control of Biochemical Reactions to Stresses in Space Environment (Cont'd)	Urine Analyses: Volume Sodium Potassium Chloride Osmolality Calcium Phosphate-(PO ₄) Magnesium Creatinine Antidjuretic hormone Aldosterone Cortisol	Significant increases in urinary antidiuretic hormone occurred early in-flight in all men. Due to inability to refrigerate the urine sample obtained on the first day in-flight, it could not be analyzed for this hormone. 21 Urine analyses from Skylab missions. 40
A	Epinephrine Norepinephrine Total 17-Hydroxycorticosteroids Total 17-Ketosteroids Uric Acid	

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	FUNCTIONS/MEASUREMENTS
RESEARCH DISCIPLINE	REQUIRED
BIOMEDICINE	
Deale and Committee	
Basis and Control of Biochemical Reactions	Plasma & Serum Analyses:
	Sodium*
to Stresses in Space Environment (Cont'd)	Potassium*
Environment (Cont o)	Calcium*
	Magnesium Chloride*
	*
	Phorphorus* Osmolality*
	Carbon dioxide
	Cholesterol
	Triglycerides
	Adrenocorticotrophic hormone* Cortisol*

	Angiotensin I*
	Aldosterone*
	Insulin*
	Blood urea nitrogen
	Urie acid
	Creatinine*
	Total protein
	Alkaline phosphatase
	Serum glutamic oxaloacetic
	transaminase (aspartate
	aminotransferase)
	Creatine phosphokinase
	Lactic dehydrogenase
	Glucose*
	Total bilirubin
	Growth hormone

Thyroxine

Testosterone
Parathormone*
C.deitonin
Vitamin D

Thyroid stimulating become

*Determined during flight

It is concluded that mineral losses do occur from the bones of the lower extremities during missions of up to 84 days and that in general, they follow the loss patterns of the bedrested situation. The levels of loss observed in the Skylab crews have been of no clinical concern but it was fortuitous that all of the Skylab 4 crewmen had high prediction terms. ²²

PRIORITY DETERMINANTS

Plasma analyses from Skylab missions. 41

The in-flight decreases observed in both glucose and insulin have also been observed in bedrest, although it did not become significant until 56 days in bedrest, while the decrease became significant at 38 days in space. ²³

	FUNCTIONS/MEASUREMEN
RESEARCH DISCIPLINE	REQUIRED

WTS. REQUIRED

BIOMEDICINE

Vestibular System

Study the mechanical and neural responses of the otolith organs to stimuli in the space environment.

investigate role of visual cues in space nausea.

Pharmacological prevention and treatment of space nausca.

Role of altered body fluid volume, pressure and distribution to space nausea.

Invasive studies on animals.

Study mechanical and neural responses of the vestibular system to stimuli in the space environment

Apply calibrated stimulus to otoliths:

- linear acceleration - angular acceleration Record ocular reflex motions Measure ocular muscle potentials

Repeat Skylab M131 experiment with eves open. Relate crew/spacelab orientation to signs and symptoms of spatial disorientation.

Relate pharmacological administration to signs and symptoms of space nausea.

Body fluid compartment volumes:

- total body water
- extracellular volume
- plasma volume Venous capacitance Systolic blood pressure Diastolic blood pressure Anthropometric measurements Time-related signs and symptoms of space nausea.

Animal subject with implanted sensors and stimulation devices. Apply calibrated stimulus to

- vestibular organs:
- linear acceleration
- angular acceleration
- electrical stimulation
- pressure stimulation Record ocular reflexes, righting re-

flexes & muscle potentials. Record signs & symptoms of space nausea.

PRIORITY DETERMINANTS

7

It appears that a relatively modest amount of crew time may have been lost due to motion sickness on Skylab missions 3 and 4 but that each crew's performance was never substantially impaired for more than one day. 24

In Skylab 4 the Scientist Pilot did not experience motion sickness. The Commander had minimal malaise for three days. The Pilot had significant nausea with vomiting for one day and then malaise for two more days. 25

Under operational conditions seven of the nine crewmen experienced motion sickness, five of the seven while in orbit. The administration of antimotion sickness drugs made it difficult or impossible accurately to determine the level of susceptibility at all times. The Skylab 2 crewmen did not experience clear-cut symptoms aloft and only the Scientist Pilot experienced seasickness: indeed, the Commander and Pilot did not take drugs, yet remained symptom free throughout the mission. Among the Skylab 3 crew the Pilot experienced motion sickness shortly after transition into orbit, the earliest diagnosis on record. The two remaining crewmon first experienced motion sickness shortly after entering the workshop. For a period of three days symptoms were controlled by drugs and by restricting activity. Recovery was complete by mission day seven. The Skylab 4 crewmen were scheduled to take antimotion sickness medication but only the Scientist Pilot avoided symptoms. 26

First, with the background supplied by M-131, advisably carried out in Skylab without vision, it would be of great interest to employ the same methodology to further explore the role of vision. 27

Among these findings, the occurrence of motion (space) sickness symptoms during the first few days of space flight is of paramount operational importance for the forthcoming Shuttle flights. 26

	RESEARCH DISCIPLINE	FUNCTIONS/MEASUREMENTS REQUIRED	PRIORITY DETERMINANTS
	BIOMEDICINE		
	Hematology		•
	Man	Collect, prepare & preserve blood samples Measure red blood cell mass Obtain reticulocyte counts Measure blood O ₂ tension Measure blood granulocytic response to inflammatory stimuli	Analyses of data from the rod cell mass determinations indicate that the red cell mass drops occurred in the first 30 days of flight and that a gradual recovery of the red cell mass deficits began approximately 60 days after launch. 29 The loss of circulating red cells was also maximal at 20 to 40 days and decreased after that time. However, the recovery of red cell mass was independent of weightlessness or normal gravity after the initial insult. 30
∆_ 2A	invasive studies on animals	Collect, prepare, & preserve blood samples Measure red blood cell mass Obtain reticulocyte counts Perform bone marrow biopsies Measure total blood volume Measure blood O ₂ tension Provide animal maintenance Provide animal physiological monitoring Provide erythropoietic stimulus: - acute blood loss - tissue hypoxia	

FUNCTIONS/MEASUREMENTS

RESEARCH DISCIPLINE

REQUIRED

PRIORITY DETERMINANTS

BIOMEDICINE

Microbiology

Effects of space environment upon host defense mechanisms

- Man

Alteration in normal bacterial

microflora: - nasal sampling

- skin sampling

- air sampling

- spacelab surface swabs

Microbial mutation

These data show that, while gross contamination of the Skylab environment was demonstrated and there were several in-flight disease events (presumably of microbial origin), such events were not shown to be limiting hazards for long-term space flight. 42

The question of in-flight autoinfection remains unanswered because none of the in-flight disease events were evaluated

microbiologically.

- Animals

Experimentally induced infection

(non-pathogenic strain for man) Maintenance of animals

Microbial mutation

Measure specific immune response:

- macrophage activity

- lymphocytic response

- thymus gland response

- immune globulin synthesis

Blood sample collection and

preservation

Incubate microbial cultures

Examination of the effects of the spaceflight environment on latent and slow virus infections experimentally induced in animals. 44

Studies, both animal and human, of the effects of isolation on susceptibility to infection, particularly as related to the re-entry problem and microbial shock. 45

FUNCTIONS/MEASUREMENTS RESEARCH DISCIPLINE REQUIRED PRIORITY DETERMINANTS BIOMEDICINE Conduct time and motion studies A second feature bearing directly on the Shuttle program is the protracted period of space sickness malaise and loss of appetite Crew Performance on a non-interference basis with encountered by a sizeable proportion of Skylab astronauts. Bearing in mind the short duration of the average Skuttle mission, it In Space scheduled, repetitive mission seems inevitable that effectively novice personnel engaged in research or other activities will be penalised by reducing work potential unless some form of successful preconditioning regimen is discovered. 32 or training tasks and observe and record: - work space layout and lighting It was found that on only two of the total of nine full or partial activation days was the crew work output significantly reduced. On - crew restraints the day of lowest efficiency, mission day 2 of the Skylab 3 mission, it appears that the crewmen were working at approximately - equipment operation task 75 percent of their "normal" efficiency and may have lost approximately 7 man-bours of work. Overall, a nearly constant level efficiency of work was achieved on these activation days. However, as crew proficiency improved later in the missions, the daily crew work - experimental task efficiency output in these same categories increased from approximately a 26 man-hour/day to at least a 34 man-hour/day. 33 - task related movements of the subject Behavioral performance continued to improve from beginning to end of all Skylab missions. 34 - interpersonal reactions Time relate performance measures with daily activity schedules, sleep patterns, environmental conditions and biomedical measurements Correlate crew performance The Skylab Medical Experiments Altitude Test (SMEAT) was an integral part of the Skylab Program. SMEAT served both to gather Effects of Training Upon Space Crew Efficiency vital baseline biomedical data and to resolve many of the equipment and procedural problems which otherwise might have impaired efficiency measurements in Skylab, 35 Spacelab missions with performance efficiency measured on the same task(s) when conducted previously in groundbased simulators or Spacelab flight training activities.

RESEARCH DISCIPLINE FUNCTIONS/MEASUREMENTS REQUIRED BIOLOGY

Cellular & Molecular Biology

Density dependent growth and development processes

Wound repair rates
Cellular movement
intracellular movement
Membrane electrolyte transport
Maintain tissue cultures
- bone marrow

intestinal epitheliumembryonic tissues

Cell turnover times

Genetic alterations in zero-g

Cell division
Mitotic abnormalities
Chromosome aberrations
Histological preparations
Specimen preservation
Monitor environment

Higher Vertebrate Biology (non-human primates)

Lower Vertebrate Biology (rats, guinea pigs, frogs)

-Basic mechanisms of physiological adaptation, growth, development and reproduction in zero g. Described under biomedical requirements.

Maintenance of instrumented animals Animal restraints Metabolic monitoring - food/fluid intake

- urine, feces, blood collection - circadian cycles
- Physiological monitoring cardiorespiratory
- vestibular adaptation to calibrated stimulation
- behavior patterns Histological preparations
- bone marrow crythropoleses
- wound healing

- genetic changes

PRIORITY DETERMINANTS

While certain of the projected experiments in the life sciences can be accomplished within the span of 7-day missions, others, such as those concerned with embryonic and fetal development, wound healing, and other aspects of cellular proliferation (e.g., marrow, skin, and gut), will require the full capability of the 30-day mission. 31

Enables invasive studies and critical control of experimental parameters of basic importance to understanding of human responses to space stresses.

The non-human primates, due to anatomical, physiological, and blochemical characteristics of man, can provide research data transferable to man.

30-day exposures of small mammals to zero-g effects should provide important information regarding basic factors which also affect man

Changes in activity of enzymes in heart, skeletal muscle, endocrine glands, and changes in bone marrow hematopoieses have been demonstrated in rats exposed to 22 days of zero g.

RESEARCH DISCIPLINE	FUNCTIONS/MEASUREMENTS REQUIRED	PRIORITY DETERMINANTS
BIOLOGY	1	
Lower Vertebrate Biology (rats, guinea pigs, frogs) Cont'd		•
	Surgery, biopsy, autopsy - organ development - reversible/frreversible deconditioning Radioisotope injection Litter rearing Development stages Animal morphology Mass measurement Effects of fractional g Environmental monitoring - atmosphere /contaminants - acceleration - noise - radiation	Statistical numbers of experimental subjects can be maintained in space with less weight, volume, and power penalties than encountered for large primates.
invertebrates (insects, spiders, nematodos)		·
Basic mechanisms of physiological adapta- tion, growth, develop- ment & reproduction in zero g	Specimen maintenance through entire life cycles Monitor behavior patterns Monitor activity cycles Monitor reproduction Monitor growth rate Monitor development stages Monitor morphology Histological preparations for: - organ development - genetic changes - structural changes Specimen fixing & preservation for: - chemical changes Environmental monitoring - atmosphere/contaminants - airborne particulates - temperature/burnidity	Enable complete life cycle studies which could provide important basic understanding of effects of prolonged zero g exposures on genetic, growth, development and reproduction factors.

	RESEARCH DISCIPLINE	FUNCTIONS/MEASUREMENTS REQUIRED	PRIORITY DETERMINANTS
	ENOLOGY Invertebrates (insects, spiders, nematodes, cont'd) Plant Biology	Environmental monitoring (cont'd) - noise - acceleration - radiation	•
A _ A 1	Basic mechanisms of growth, development, and reproduction in zero g	Specimen maintenance through several entire life cycles. Monitor: - geotropism - growth rate - morphology - photosynthetic activity - circadian cycles - productivity - life cycles Histological preparations for: - genetic changes - cellular replication - structural changes Specimen fixing & preservation for: - enzyme activity - chemical changes Mass measurement Effects of fractional g Environmental monitoring: - atmosphere - temperature - acceleration - radiation	Equal attention should be directed toward growth and development of plant cells in 0 g. For example, does the absence of gravity influence the morphogenesis of plant cells and affect chromosome replication to alter the mechanism of cell division? 46 the obvious question, derived from extrapolation of the possible effects of weightlessness on chromosome replications, is whether plants can grow and develop normally in long-duration spaceflight. For example, can a microalgae population continue in a normal fashion after several generations at 0 g? Such information would be essential if one were to propose plant systems as secondary life-support systems in long-duration spaceflights. The conditions of the possible evolutionary mechanisms of terrestrial plants. 48 Thus, among the fungi raised under conditions of weightlessness there was much poorer development of the supporting tissues, while the pedicel supporting the spore was much thicker and in area the fungus exceeds that of the "terrestrial variety". 50

RESEARCH DISCIPLINE	FUNCTIONS/MEASUREMENTS REQUIRED	PRIORITY DETERMINANTS
BIOLOGY		20
Radiobiology		\dots one of the most neglected problems in biology — the vulnerability of themammalian tissues to cosmis ray particles. 36
Biological effects of HZE particle irradiation	HZE particle detector Maintenance of: - small animals	Enables study of molecular basis of zero-g effects upon cell division.
	 plants tissue cultures (described under vertebrates, invertebrates & plant biology) 	Missions in low-inclination (\leq 30°) near-earth orbits do not present an HZE-particle hazard. Therefore, the urgency of securing the needed data depends on the schedule for long-duration (\geq 2 year) flights outside the earth's magnetosphere or in earth orbits inclined more than about 30° to the equator. 37
	Histological preparations for: - genetic changes - structural changes - organ development	Ground-based suidies with accelerator-produced heavy ions are thus the first requirement. NASA has the operational problem of assessing the potential hazard of HZE particles to man during long-duration space missions and should therefore take full advantage of the ground-based facilities that are becoming available. Flight studies can then be designed for proof-of-principle.
>	Lovironmental monitoring: - atmosphere - radiation	All Shuttle flights should contain dosimetric devices and materials positioned to accumulate data on the flux and energy of the several radiations in space and the shielding effect of spacecraft components on their intensity and scattering. 49
Š	- temperature/humidity - acceleration	

A - 42

	RESEARCH DISCIPLINE	FUNCTIONS/MEASUREMENTS REQUIRED	PRIORITY DETERMINANTS
	LIFE SUPPORT & PROTECTIVE SYSTEMS		
	Life Support Hardware Testing in Zero G e.g., Condensers Vapor Cycle Units Sterilizors CO ₂ Reduction Biopacks Pressure Suits	Analyze gas mixtures Fluid sample transfer Vacuum supply management Fluid supply management Electrical power measurements Coolant supply management Low temperature specimen storage Isolation of process loops from cabin atmosphere Pressure suit testing	Determine the feasibility of using vapor compression refrigeration systems in the space environment. Develop advanced LSS hardware for water reclamation, waste management, atmospheric conditioning and purification, oxygen regeneration, feeding, and personal hygiene. Develop pressure suits and biopacks for more efficient EVA activity. Develop efficient air sterilization methods.
A-43	Effects of Space Inertial Forces on Gravity Sensitive Processes Mixed Phase Fluid Flow Liquid/Gas/Solid Phase Separation and/or Mixing Characteristics Heat Transfer Characteristics	Measure: - fluid temperature - fluid pressure - fluid flow - fluid quality - fluid energy rates - color motion pictures of phase mixing - g lovel	Determine gravity influences on flow regimes and flow regimes influences on pressure drop, thereby providing a basis for engineering optimization of fluid systems for space applications. Develop design parameters for minimum energy separation over spectrum of liquid/gas ratios from near zero to near infinity. Develop design parameters for minimum energy phase mixing. Determine single phase and phase change heat transfer parameters.
	MAN-SYSTEM INTEGRATION Man-Machine Testing of Advanced Designs	Provide crew inputs to operate, service and control hardware test items in zero g. Validate crew task time altocations. Validate hardware performance in zero g. Establish workspace/restraint requirement.	Skylab medical experiment equipment functioned without problems throughout the three flights. Medical data of high quality were obtained for all experiments. 39 Evaluation of teleoperator systems (free-flying) in deploying, retrieving, & servicing satellites remote from the shuttle.

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APPENDIX B RESEARCH CAPABILITY OF DEFINED PAYLOADS

APPENDIX B

RESEARCH CAPABILITY OF DEFINED PAYLOADS

The research capability for each of the 16 candidate payloads defined in this study is shown in the following pages. There are two tables for each payload. The first indicates the main research requirements, the specific capability, and the major equipment used. The second, and immediately following table, is the total common equipment listing for the payload. The following table indicates the complement of payloads and their order.

Type	Designation	Research Emphasis
Carry-On	Col-2A	Biomedicine - Blood Sampling
	Col-3A	Biomedicine - Urine, Electrolytes
Mini-Lab	ML-1A (first S/L mission)	Biomedicine - OFO, Vestibular, Urine, Single Cell Studies
	ML-2A	Biomedicine/Biology - Small Vertebrates
	ML-3A	Biomedicine - Man
	ML-4A	Life Support/Protective Systems
	ML-5A	Man Systems Integration
	ML~2B	Biomedicine/Biology - Primates
	ML-2C	Biomedicine/Biology - Small Vertebrates/ Cells & Tissues
	ML-2D	Biology - Small Verts., Plants, C&T, Invertebrates
Dedicated	MOD IA	Biomedicine - Man, Vertebrates, Cells & Tissues
	MOD IIA	Biomedicine/Biology/Adv. Technology
	MOD IIIA	Biomedicine/Biology/Adv. Technology - Centrifuge
	MOD IIB	Biology/Biomedicine
	MOD IIC	Biology/Biomedicine
	MOD IIIB	Biology/Biomedicine - Centrifuge

BLOOD SAMPLING CARRY-ON LAB COL-2A

			i	Kit .
Research Requirements	Specific Capability	Centrif.	Freezer (Hematology
Biomedicine Cardiovascular Gauer-Henry reflex Biochemical response to stress	Obtain first-day on-orbit biochemical measure- ments defining enzyme/endocrine concentrations relating to plasma volume regulation (ADH, aldosterone, renin, angiotensin).	x	х	x
	Method — draw blood, prepare, freeze, return for ground analysis.			

Note: If simultaneous blood and urine samples are required for correlative studies, this payload can be combined with COL-3A. However, 23 kg limit is exceeded.

PAYLOAD BLOOD SAMPLING CARRY-ON

NO. COL-2A

EI#	EI NAME	Q	UNIT WEIGHT kg	UNIT POWER W	UNIT VOLUME dm ³
40A	Centrifuge, Blood Sample Processor	1	12.7	100	25
81	Freezer, Low Temp	1	8	10	30.5
106	Kit, Hematology & Urology	1	0.2	0	0.5
116	Log Books	1	0.5	0	0.4
	LN ₂ . (for EI 81)	1	3.8	0	2
	TOTAL WEIGHT		25.2		
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URINE SAMPLING CARRY-ON LAB COL-3A

	Research Requirements Specific Capability iomedicine Cardiovascular Body fluid/electrolytes and renal function adaptations to weight- lessness Delayed body fluid compartment changes, pre- & post-fit.	Major Eqpt.		rapes
Research Requirements	Specific Capability	Freeze	Urology	Anthr.
Body fluid/electrolytes	urine volumes, prepare, freeze & store for general	x	х	x
	Perform anthropomorphic measurements to define body fluid shifts in zero-g.			x

Note: If simultaneous blood and urine samples are required for correlative studies, this payload can be combined with COL-2A. However, 23 kg limit is exceeded.

PAYLOAD URINE SAMPLING CARRY-ON COL-3A

EI#	EI NAME	Q	UNIT WEIGHT kg	UNIT POWER W	UNIT VOLUME dm ³
44A	Chemicals, Radioisotope Tracers	1	0.3	0	0.5
81	Freezer, Low Temp	1	8	10	30.5
106	Kit, Hematology & Urology	1	5	0	9
110C	Kit, Human Physiology	1	3	0	8
116	Log Book	1	0.5	0	0.4
	TOTAL WEIGHT		16.8		
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		N	[ajc	r	Eq	uip	me	nt	
		OFO Packages (2)	dng Litter	Hem. /Urology Kits	Freezers	Centrifuge Proc.	Human Phys. Kit	Auto. Poten.Elec. Anal	Woodlawn Wanderer
Research Requirements	Specific Capability	<u> </u>	Н		_				
Biomedicine									
Vestibular	Mechanical & neural responses of otolith organs to zero-g.	X	i i						
	Role of visual cues to space nausea.	İ	x						
	Role of altered body fluid volume, pressure & distribution to space nausea.			x	X	×			
Cardiovascular	Gauer-Henry reflex.		li	x	х	x			
	ECG, VCG						x		
	Anthropomorphic measurements of fluid shifts.	i					x		
	Altered vascular flow, volume & pressure relationships.			x	x		x		
Biochemical Reactions	Measure stress hormone, enzyme, fluid/electrolye & fluid volume changes.							x	
Cellular Physiology	Single-cell type culture responses to zero-g — bone marrow.								X

PAYLOAD FIRST US/ESA SPACELAB MISSION
NO. M-L 1A

NO.	M-	L

EI#	EI NAME	Q	UNIT WEIGHT kg	UNIT POWER W	UNIT VOLUME dm ³
6A	Airflow Work Surface	1	5	75	6
7A	Auto. Poten. Elec. Analyzer	ī	12.7	100	57
31	Calculator, Pocket	1 1	0.47	0	0.4
36	Camera, 35 mm & Strobe	1	2	0	2
37	Camera, Video, B/W	1	4.4	15	3
40A	Centrifuge, Blood Sample	1	12.7	100	25
51F	Coolant Loop, Liquid	1	30	50	25
63C	Display, Numeric	1	2	2	4
70C	Equipment Restraint Device	1	0.5	0	1
76C	Film, 35 mm	3	0.13	0	0.05
80	Freezer	1	15	200	61.4
81	Freezer, Low Temp.	1	8	10	30.5
106	Kit, Hematology & Urology	1	5	0	9
106A	Kit, Cleanup	1	1.5	0	4
110	Kit, Microbiology	1	2	0	3
110C	Kit, Human Physiology	1 1	3	0	8
114E	Lamp, Portable Hi Int. Photo	1	6.3	150	6
116	Log Books	1	0.5	0	0.4
126	Microscope, Compound	1	11	15	27.4
126J	Microscope Accessory Kit, Compd.	1	10	15	25
131J	OFO Experiment Packages	2	45	20	80
132	Oscilloscope & Camera	1	11.7	75	28.9
153	Recorder, Voice	1	1	0	1
153A	Rotating Litter Chair/Console	1	100.2	127	. 239
156	Signal Conditioners (Couplers)	6	0.2	2	0.5
182E	Urine Volume Measurement System	1	In Orl	biter	İ
187C	Woodlawn Wanderer	1	10	1.5	12.9
	TOTAL WEIGHT		347		:
					i

BIOMEDICINE/BIOLOGY MINI-LAB - SMALL VERTEBRATES M-L 2A

The same of the sa	•	<u> </u>	Ma	ijo	r E	qu	ipr	ner	ıt
Research Requirements	Specific Capability	Small Vert. Cages (16)	Freezers	Mass Spectrometer	Auto. Poten. El. Anal.	Centrifuge, Blood	Hem, /Urol. Kits	Vert. Phys. Kit	ledg. System Hetalogy Kit
nesearch negurements	<u> </u>	02	Ŧ		₹;	٦	<u>111</u>		<u> </u>
Biomedicine	ı		•					1	i
Cardiovascular	Altered vascular flow/volume/pressure relationships. Internal blood flows, pressures; urine & blood collection, freeze & store; food & fluid intake, biochem. analysis.	x	x			X	X	x	
	ECG/pulse, Doppler flowmeter. Demonstrate myocardial degeneration resulting from zero-g.		•		1			x	X
Musculoskeletal	Absolute catabolic effects of zero-g. Food & fluid intake; histological preparations of bone, bone marrow, muscle.							x	x
Hematology	Invasive studies — measure total blood volume, red blood cell mass, blood Ω_2 tension; obtain reticulocyte counts; collect, prepare & store blood samples.		x		x		x	x	
Biochemical Reactions	Fluid & electrolyte balance, Ca regulation, adrenal function. Urine collection, preservation & analysis.		X		x		ж		
Pulmonary	On-board & ground analysis. Respiratory gas analysis	x		x					

BIOMEDICINE/BIOLOGY - SMALL VERTEBRATES MINI-LAB PAYLOAD M-L 2A

NO.

UNIT UNIT UNIT WEIGHT POWER VOLUME dm^3 Q kg EI# EI NAME Air Particle Sampler 1 2.7 50 0.85 6 6A Airflow Work Surface 1 5 75 6 100 57 7A Auto. Poten. Electrolyte Anal. 1 12.7 11 16 2.3 9 30A Cage, Rat, Hamster, Std. 2 2 Camera, 35 mm & Strobe 1 0 36 38 Camera, Video, Color 1 7.7 69 6.2 100 25 40A Centrifuge, Blood Sample Proc. 1 12.7 1 0 0.5 44A Chemicals, Radioisotope Tracers 0.31 2.3 100 10 48 Cleaner, Vacuum 51 F 1 30 50 25 Coolant Loop, Liquid 4 Display, Numeric 1 2 2 63C 1 0.5 0 1 70C Equipment Restraint Device 76C 5 0.13 0.05 Film, 35 mm Freezer, General 1 15 200 61.4 80 1 30.5 81 Freezer, Low Temp. 8 10 120 83 Frig. (Refrigerator) 1 18 50 1 25 50 20 91 Gas Analyzer, Mass Spec. 25 96 Glove Box. Portable 1 4.5 0 10 0.5 0 1 96C Glove Box Liners 0 188 103 Holding Unit, Small Vert. 2 13.6 1 5 8 Incubator 5 103B 5 9 106 Kit, Hematology & Urology 1 1 1.5 0 4 106A Kit, Cleanup 1 108 1 1 0 Kit, Histology 1 2 0 3 Kit, Microbiology 110 3 0 8 110C Kit, Human Physiology 1 1 1 0 2 114A Kit, Dissection Kit, Vertebrate Mgmt. 1 3 0 6 114B 1 6 114C Kit, Vertebrate Physiology 3 0 6 1 6.3 150 114E Lamp, Portable Hi Int. Photo 2 0 0.4 116 Log Books 0.5 27.4 1 11 15 126 Microscope, Compd. 1 100 28 9 126A Microscope, Dissecting 126J Microscope Access. Kit, Compound 1 10 15 25 1 11.7 75 28.9 132 Oscilloscope & Camera 1 0 1 153 Recorder, Voice 1 12 0.2 2 0.5 156 Signal Conditioners (Couplers)

PAYLOAD BIOMEDICINE/BIOLOGY - SMALL VERTEBRATES MINI-LAB (Cont'd) NO. M-L 2A

EI#	EI NAME	Q	UNIT WEIGHT kg	UNIT POWER W	UNIT VOLUME dm ³
165	Sterilizer, Tool	1	1	110	1
174	Tank, Vertebrate Water	1	8.5	5	28.3
180	Timer, Event	1	0.2	0	0.2
182P	Ventilation Unit, Vert.	1	19	40	32.7
188	Work & Surgical Bench	1	136	1000	420
	TOTAL WEIGHT		460		
		<u> </u>			
				:	

Research Requirements Biomedicine - Man Cardiovascular Altered vascular flow/volume/pressure rela Internal blood flows, pressures, Doppler urine & blood collection, freeze & store; intake, biochemical analysis. ECG, VCG pressures, pulse; Use of echocard determinations of stroke volume, cardiac compliance. Body fluid compartment studies — total body plasma volume, renal blood flow. Vestibular Role of altered body fluid volume, pressure to space nausea.	Poten. El, Analyzer	Bl. Proc.		ol. Kit	Kit	nalyzer	Eqmt.
Cardiovascular Internal blood flows, pressures, Doppler urine & blood collection, freeze & store; intake, biochemical analysis. ECG, VCG pressures, pulse; Use of echocard determinations of stroke volume, cardiac compliance. Body fluid compartment studies — total body plasma volume, renal blood flow. Vestibular Role of altered body fluid volume, pressure to space nausea.	Auto.	Centrifuge,	Freezer	Hemat./Uro	Human Phys	Cardiopul. A	Exer. Physiol.
Cardiovascular Internal blood flows, pressures, Doppler urine & blood collection, freeze & store; intake, biochemical analysis. ECG, VCG pressures, pulse; Use of echocard determinations of stroke volume, cardiac compliance. Body fluid compartment studies — total body plasma volume, renal blood flow. Vestibular Role of altered body fluid volume, pressure to space nausea.	tionshins		x	•			
intake, biochemical analysis. ECG, VCG pressures, pulse; Use of echocard determinations of stroke volume, cardiac compliance. Body fluid compartment studies — total body plasma volume, renal blood flow. Vestibular Role of altered body fluid volume, pressure to space nausea.	- 1 :	^	^		^	•	
ECG, VCG pressures, pulse; Use of echocard determinations of stroke volume, cardiac compliance. Body fluid compartment studies — total body plasma volume, renal blood flow. Vestibular Role of altered body fluid volume, pressure to space nausea.	; food & fluid						
determinations of stroke volume, cardiac compliance. Body fluid compartment studies — total body plasma volume, renal blood flow. Vestibular Role of altered body fluid volume, pressure to space nausea.	diogram for				x		I
Body fluid compartment studies — total body plasma volume, renal blood flow. Vestibular Role of altered body fluid volume, pressure to space nausea.	- ,						
Vestibular plasma volume, renal blood flow. Role of altered body fluid volume, pressure to space nausea.	water volume		;		x		1
to space nausea.	water volume,		i		Î		
	and distribution	İ			x		
Pharmacological prevention and treatment of	- 1 ;	İ			х		
Biochemical Reactions Fluid & electrolyte balance, Ca regulation, a function. Urine collection, preservation On-board & ground analysis.	1 ;		X :	X	×		
Hematology Collect, prepare & preserve blood samples. red cell mass (Cr ⁵¹), plasma volume (I ¹² granulocyte response to inflammatory stir	²⁵), blood	x }	x	x	х	[
Musculoskeletal Exercise effect upon musculoskeleta disarra	j 1		ì		\mathbf{x}	x	\mathbf{x}
Calibrated exercise level, respiratory pa			:	'	1	i	
Pulmonary ECG/VCG, pressures, muscle mass, stream Pulmonary Altered pulmonary volume/flow relationships	envin relieves. 1 i		:		İ	x	
Measurements of respiratory gas partial	1 1		Ì	!			
flows. Derived quantitites - VC, FVC, T pulmonary capillary blood flow/volume.	s in zero-g — pressures,		1		- 1	. !	

PAYLOAD

BIOMEDICINE MINI-LAB

NO.

M-L 3A

EI#	EI NAME	Q	UNIT WEIGHT kg	UNIT POWER W	UNIT VOLUME dm ³
6A	Airflow Work Surface	1	5	75	6
7A	Auto. Poten. Electro. Analyzer	1	12.7	100	57
36	Camera, 35 mm & Strobe	l ī	2	0	2
37	Camera, Video B/W	1	4.4	15	3
38F	Cardiopulmonary Anal.	1	90.7	200	172
40A	Centrifuge, Blood Sample Processor	1	12.7	100	25
44A	Chemicals, Radioisotope Tracers	1	0.3	0	0.5
51F	Coolant Loop, Liquid	1	30	50	25
63C	Display, Numeric	1	2	2	4
70C	Equipment Restraint Device	1	0.5	0	1
70E	Exercise Eqmt., Physic.	1	96	18	992
76C	Film, 35 mm	3	0.13	0	0.05
80	Freezer, General	1	15	200	61.4
81	Freezer, Low Temp.	1	8	10	30.5
83	Frig. (Refrigerator)	1	18	50	120
106	Kit, Hematology & Urology	1	5	0	9
110C	Kit, Human Physiology	1	3	0	8
114E	Lamp, Portable Hi Int. Photo	1	6.3	150	6
116	Log Books	3	0.5	0	0.4
132	Oscilloscope & Camera	1	11.7	75	28.9
153	Recorder, Voice	1	1	0	. 1
156	Signal Conditioners (Couplers)	6	0.2	2	0.5
180	Timer, Event	1	0.2	0	0.2
182J	Vectorcardiogram Coupler	1	0.2	2	0.5
	TOTAL WEIGHT		328		
1					
1					

LIFE SUPPORT/PROTECTIVE SYSTEMS MINI-LAB M-L 4A

				ajo		
Research Requirem <i>e</i> nts	Specific Capability	LSS Test Console	Liquid Supplies/Handling	es/Ha	s Spectro	Recording Equipment
Life Support/Protective Systems	Life support hardware testing in zero g Provide gas, liquid, electrical, thermal requirements. Analyze gas mixtures, temperatures, flows, voltages, powers, etc. Record data. Gravity-sensitive processes study Study fundamental fluid dynamic and thermodynamic phenomena. Interface with experimental apparatus. Measure physical parameters. Record data.	X	x			

7

PAYLOAD LIFE SUPPORT/PROTECTIVE SYSTEMS MINI-LAB NO. M-L 4A

			UNIT	UNIT	UNIT
			WEIGHT	POWER	
EI#	EI NAME	Q	kg	w	dm^3
31	Calculator, Pocket	1	0.47	0	0.4
32	Camera, Cine	1	5	13	5
36	Camera, 35 mm & Strobe	1	2	0	2
37	Camera, Video B/W	1	4.4	15	3
48	Cleaner, Vacuum	1	2.3	100	10
63C	Display, Numeric	1	2	2	4
70C	Equipment Restraint Device	1	0.5	0	1
75C	Film, Cine	8	0.54	0	0.54
76C	Film, 35 mm	3	0.13	Ò	0.05
76J	Flowmeter s	4	0.5	1	0.5
83	Frig. (Refrigerator)	1	18	50	120
87	Gas Analyzer, Infrared	1	11.3	50	42.6
91	Gas Analyzer, Mass Spec.	1	25	50	20
93A	Gas Supplies	2	5.75	0	18
105	Kit, Chemical	1	1.5	0	5
106A	Kit, Cleanup	1	1.5	0	4
114E	Lamp, Portable Hi Int. Photo	1	6.3	150	6
114G	Liquid Storage & Disp. Sys.	1	13	0	18
115F	LSS Test Console	1	15	0	560
116	Log Books	1 1	0.5	0	0.4
118I	Manifold, Vacuum	1	9.1	0	28.3
122	Mass Meas. Device, Micro	1	12	15	25
134B	Paper, Recording	3	0.6	0	1.2
141A	Plumbing	1	20	2	15
150A	Recorder, Strip Chart	1	11.8	0	16.9
153	Recorder, Voice	1	1	0	1
180	Timer, Event	1	0.2	0	0.2
185	Multimeter	1	2	0	2.4
·					
•	TOTAL WEIGHT		135		
		1			
			1		
				[

Research Requirements	Specific Capability	ī	•	ooks	
Man-Systems Integration		x	ж	x	

PAYLOAD MAN-SYSTEMS INTEGRATION MINI-LAB M-L 5A

NO.

EI#	EI NAME	Q	UNIT WEIGHT kg	UNIT POWER W	UNIT VOLUME dm ³
36	Camera, 35 mm & Strobe	1	2	0	2
38	Camera, Video, Color	1	7.7	69	6.2
38B	Camera Mounts	1	3	0	3
38D	Camera Timer, Video	1	4	10	3
70C	Equipment Restraint Device	1	0.5	0	1
76C	Film, 35 mm	2	0.13	0	0.05
114E	Lamp, Portable Photo Hi Intensity	1	6.3	150	6
116	Log Books	1	0.5	0	0.4
153	Recorder, Voice	1	1 .	0	1
180	Timer, Event	1	0.2	0	0.2
	TOTAL WEIGHT		25.5		

BIOMEDICINE/BIOLOGY MINI-LAB - PRIMATES M-L 2B

	and the second of the second o	Major E						ne	nt ,
Research Requirements	Specific Capability	Primate Cages (2)	20	Freezers	Mass Spectrometer		fuge,	/Urol.	Vert. Phys. Kit Rode Sestem
		一							7
<u>Biomedicine</u> Cardiovascular	Altered vascular flow/volume/pressure relationships. Internal blood flows, pressures; urine & blood col-	x	x	x			ж	x	x
	lection, freeze & store; food & fluid intake, biochem. analysis. ECG/VCG/pulse, Doppler flowmeter.								x
Vestibular	Invasive studies on animals.								
	Implanted sensors/stimulation devices. Calibrated stimuli to vestibular organs, record ocular reflexes, signs & symptoms, EOG	x	x						X
Pulmonary		х	x		x			1	
Biochemical Reactions	Fluid & electrolyte balance, Ca regulation, adrenal func. Blood & urine collection, preservation and analysis. On-board & ground analysis.		X	x		x	x	ж	

PAYLOAD BIOMEDICINE/BIOLOGY - PRIMATES MINI-LAB

NO. M-L 2B

			UNIT WEIGHT	UNIT POWER	UNIT VOLUME
EI#	EI NAME	Q	kg	w	dm ³
6	Air Particle Sampler	1	2.7	50	0.85
6A	Airflow, Work Surface	1	5	75	.6
7A	Auto. Poten. Electrolyte Anal.	1	12.7	100	57
36	Camera, 35 mm & Strobe	1	2	0	2.0
38	Camera, Video, Color	1	7.7	69	6.2
40A	Centrifuge, Blood Sample Proc.	1	12.7	100	25
44A	Chemicals, Radioisotope Tracers	1	0.3	0	0.5
48	Cleaner, Vacuum	1	2.3	100	10
51 F	Coolant Loop, Liquid	1	30	50	25
63C	Display, Numeric	1	2	2	4
70C	Equipment Restraint Device	1	0.5	0	1
76C	Film, 35 mm	5	0.13	0	0.05
80	Freezer, General	1	15	200	61.4
81	Freezer, Low Temp.	1 1	8	10	30.5
83	Frig. (Refrigerator)	1	18	50	120
91	Gas Analyzer, Mass Spec.	1	25	50	20
101B	Holding Unit, Monkey Pod	2	53	100	425
103B	Incubator	1	5	5	8
106	Kit, Hematology & Urology	1	5	0	9
106A	Kit, Cleanup	1	1.5	0	4
110	Kit, Microbiology	1	2	0	3
110C	Kit, Human Physiology	1	3	0	8
114B	Kit, Vertebrate Mgmt.	1	3	0	6
114C	Kit, Vertebrate Physiology	1 1	3	0	6
114E	Lamp, Portable Hi Int. Photo	1	6.3	150	6
116	Log Books	2	0.5	0	0.4
126	Microscope, Compd.	1	11	15	27.4
126J	Microscope Access Kit, Compd.	1	10	15	25
132	Oscilloscope & Camera	1	11.7	75	23.9
138E	Physiol. Multichannel Sens. Sys.	1	0.2	0	1.4
150B	Receiver	1	0.5	10	1
153	Recorder, Voice	1	1	0	1
156	Signal Conditioners	6	0.2	2	0.5
165	Sterilizer, Tool	1	1	110	1
174	Tank, Vertebrate Water	1	8.5	5	28.3
180	Timer, Event	1	0.2	0	0.2
182P	Ventilation Unit. Vert.	2_	19	40	32.7

TOTAL WEIGHT:

BIOMEDICINE/BIOLOGY MINI-LAB — SMALL VERTEBRATES/CELLS & TISSUES M-L 2C

			faj	j01	E	ζgι	ıiţ	m	en	t
Research Requirements	Specific Capability	Small Vert. Cages (16)		Mass Spec.	Auto. Poten. Analyzer	Centrif., Blood	Hematology/Urology Kit	Vert. Phys. Kit	Recording System	Histology Kit C&T Holding Unit
Biomedicine Cardiovascular	Altered vascular flow/volume/pressure rela- lationships. Internal blood flows, pressures; urine & blood collection, freeze & store; food & fluid intake, blochemical analysis. ECG/pulse, Doppler flowmeter.	x	x			x	x	x	×	
Musculoskeletal	Demonstrate myocardial degeneration resulting from zero-g. Absolute catabolic effects of zero-g. Food & fluid intake; histological preparations of bone, bone marrow, muscle.							x x	ţ	x x
Hematology	Invasive studies — measure total blood volume, red blood cell mass, blood O ₂ tension; obtain reticulocyte counts; collect, prepare & store blood samples.		x		×		х	x		
Biochemical Reactions	Fluid & electrolyte balance, Ca regulation, adrenal function. Urine collection, preservation & analysis. On-board & ground analysis.		x		x		x			
Pulmonary Microbiology	Respiratory gas analysis. Experimentally induced infection, measure specific immune response, incubate microbial cultures.	x		×						×
Biology Cellular & Molecular	Density dependent growth & development processes. Cell turnover rates, wound re- pair. Tissue cultures of bone marrow, in- testinal epithelium, embryonic tissues.									×

PAYLOAD BIOMEDICINE/BIOLOGY-SMALL VERTEBRATES/CELLS & TISSUES MINI-LAB M-L 2C

			1		
1	•		UNIT	UNIT	UNIT
	·	1	WEIGHT	POWER	
EI#	EI NAME	Q	kg	w	dm ³
6	Air Particle Sampler	1	2.7	50	0.85
6A	Airflow Work Surface	1	5	75	6
7A	Auto. Poten. Electrolyte Anal.	1	12.7	100	57
25B	Colony Chamber, Sealable	10	0.2	0	0.1
30A	Cage, Rat, Hamster, Std.	16	2.3	9	11
36	Camera, 35 mm & Strobe	1	2	0	2.0
38	Camera, Video, Color	1	7.7	69	6.2
40A	Centrifuge, Blood Sample Proc.	1	12.7	100	25
44A	Chemical, Radioisotope Tracers	1	0.3	0	0.5
48	Cleaner, Vacuum	1	2.3	100	10
50A	Clinostat, C/T	1	2	10	4
51F	Coolant Loop, Liquid	1	30	50	25
54	Counter, Colony, Manual	1	1.5	50	1.5
63C	Display, Numeric	1	2	2	4
70C	Equipment Restraint Device	1	0.5	lo	1
76C	Film, 35 mm	5	0.13	0	0.5
80	Freezer, General	1	15	200	61.4
81	Freezer, Low Temp.	1	8	10	30.5
83	Frig. (Refrigerator)	1	18	50	120
91	Gas Analyzer, Mass Spec.	1	25	50	20
96	Glove Box, Portable	1	4.5	10.	25
96C	Glove Box Liners	10	0.5	0	1
98A	Holding Unit, C/T	1	23	30	188
103	Holding Unit, Small Vert.	2	13.6	0	188
103B	Incubator	1	5	5	8
106	Kit, Hematology & Urology	1	5	0	9
106A	Kit, Cleanup	1	1.5	0	4
108	Kit, Histology	1	1	0	1
110	Kit, Microbiology	1	2	0	3
110C	Kit, Human Physiology	1	3	0	8
114A	Kit, Dissection	1	1	0	2
114B	Kit, Vertebrate Mgmt.	1	3	0	6
114C	Kit, Vertebrate Physiology	1	3	0	6
114E	Lamp, Portable Hi Int. Photo	1	6.3	150	6
116	Log Books	2	0.5	0	0.4
124	Media, Prepared	1	0.45	0	0.5
126	Microscope, Compd.	1	11	15	27.4

PAYLOAD BIOMEDICINE/BIOLOGY-SMALL VERTEBRATES/CELLS & TISSUES MINI-LAB NO. M-L 2C (Cont'd)

EI#	EI NAME	Q	UNIT WEIGHT kg	UNIT POWER W	UNIT VOLUME dm ³
126A	Microscope, Dissecting	1	9	100	28
126J	Microscope Access. Kit, Compound	1	10	15	25
132	Oscilloscope & Camera	1	11.7	75	28.9
138	pH Meter	1	1.8	20	5.2
153	Recorder, Voice	1	1	0	1
156	Signal Conditioners (Couplers)	12	0.2	2	0.5
165	Sterilizer, Tool	1 1	1	110	1
174 180	Tank, Vertebrate Water Timer, Event	1	8.5 0.2	5 0	28.3 0.2
182P	Ventilation Unit, Vert.	1	19	40	32.7
187C	Woodlawn Wanderer	1	10	15	12.9
188	Work & Surgical Bench	1	136	1000	420
	TOTAL WEIGHT	=	500		·
			300,		
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			1		
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		1	1	1	·

BIOLOGY MINI-LAB M-L 2D

		Maj			Major Equipe				pm	cn	
Research Requirements	Specific Capability	Sm. Vert. Holding Unit	Plant Holding Unit	Invertebrate Holding Unit		Freezers	Mass Spectrometer	Work & Surg. Bench	Microscopy	Kits - Histology, Hem.,	
Lower Vertebrate Biology (Ruts, guinea pigs, frogs, etc.) Basic mechanism of physiological adaptation, growth, development, reproduction in zero-g	Maintenance of instrumented animals, metabolic moni- monitoring, physiological monitoring. Histological preparation, incubation, examination Surgery, biopsy, autopsy	x				x	x	×	×	X X	
Plant Biology Basic mechanisms of growth, development and repro- production in zero-g	Specimen maintenance through entire life cycles. Monitor geotropism, growth rate, morphology, circadian cycles, etc. Histological preparations – genetic changes, replication Environmental monitoring		x			×	×		x	x	
Invertebrate Biology (Insects, spiders, nematodes) Basic mechanisms of growth, development and reproduction in zero-g	Specimen maintenance through entire life cycles. Monitor behavior patterns, activity cycles, morphology. Histological prep. for genetic changes, organ development, structural changes - Fix & preserve. Environmental monitoring.		1	x		×			X X	x x	
Celiular & Molecular Biology Density dependent growth and development processes	Specimen and culture maintenance, environment con- trol/monitoring. Cell turnover times, wound repair rates, electrolyte transport.				×				×	×	
Genetic alterations in zero-g	filstological preparations. Cell division, metotic abnormalities, chromosome aberrations.				x	х			X X	π •	

BIOLOGY MINI-LAB PAYLOAD M-L 2D

NO.

EI#

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UNIT UNIT UNIT WEIGHT POWER VOLUME dm^3 Q EI NAME kg W 1 Air Particle Sampler 2.7 50 0.85 1 75 6 Airflow Work Surface 5 1 57 Auto. Poten. Electrolyte Anal. 12.7 100 1 1 Anesthetizer, Invert. 0.2 0 Cage, Invertebrates 20 0.3 0 0.2 0.2 Colony Chamber, Sealable 10 0.1 0 1 4.5 Cage, Plant 0 56.6 2.3 Cage, Rat, Hamster, 13 9 11 Std. Camera, 35 mm & Strobe 1 2 0 2.0 1 7.7 . 69 6.2 Camera, Video, Color 1 Centrifuge, Blood Sample Proc. 12.7 100 25 1 0.3 Chemical, Radioisotope Tracers 0.5 0 1 2.3 100 10 Cleaner, Vacuum 1 Clinostat, C/T 2 10 4 1 30 50 25 Coolant Loop, Liquid 1 1.5 1.5 Counter, Colony Manual 50 1 2 4 Display, Numeric 1 0.5 1 Equipment Restraint Device 0 5 0.13 0.05 Film, 35 mm 0

6A 7A 14 25 25B 29 30A 36 38 40A 44A 48 50A 51F 54 63C 70C 76C 1 200 61.4 80 Freezer, General 15 1 81 Freezer, Low Temp. 8 10 30.5 83 Frig. (Refrigerator) 1 18 50 120 91 Gas Analyzer, Mass Spec. 1 25 50 20 1 5.2 93 Gas Analyzer, RH 6 13 96 Glove Box, Portable 1 4.5 0 25 15 96C Glove Box, Liners 0.5 0 1 98A Holding Unit, C/T 1 23 30 188 1 23 98C Holding Unit, Invertebrates 50 188 101 Holding Unit, Plant 1 25 500 188 2 13.6 103 Holding Unit, Small Vert. 0 188 1 103B Incubator 5 8 5 9 106 1 Kit, Hematology & Urology 0 1 1.5 4 106A Kit, Cleanup 0 108 Kit, Histology 1 1 0 1 2 110 1 0 3 Kit, Microbiology 1 1 1 111 0 Kit. Plant Mgmt. 1 113A Kit, Invert. Mgmt. 1 O 2

PAYLOAD BIOLOGY MINI-LAB
NO. M-L 2D

EI#	EI NAME	ବ	UNIT WEIGHT kg	UNIT POWER w	UNIT VOLUME dm
114A	Kit, Dissection	1	1	0	2
114B	Kit, Vertebrate Mgmt.	1	3	0	6
114C	Kit, Vertebrate Physiology	1 1	3	0	6
114E	Lamp, Portable Hi Int.	1	6.3	150	6
116	Log Books	2	0.5	0	0.4
124	Media, Prepared	2	0.45	0	0.5
126	Microscope, Compd.	1	11	15	27.4
126A	Microscope, Dissecting	1	9	100	28
126J	Microscope Access. Kit, Compound	1	10	15	25
132	Oscilloscope & Camera	1	11.7	75	28.9
138	pH Meter	1	1.8	20	5.2
153	Recorder, Voice	1	1	0	1
156	Signal Conditioners (Couplers)	12	0.2	2	0.5
165	Sterilizer, Tool	1	1	110	1
174	Tank, Vertebrate Water	1	8.5	5	28.3
175	Tank, Plant/Invert. Water	2	1.7	0	3
180	Timer, Event	1	0.2	0	0.2
182P	Ventilation Unit, Vert.	1	19	40	32.7
187C	Woodlawn Wanderer	1	10	15	12.9
188	Work & Surgical Bench	1	136	1000	420

TOTAL WEIGHT

SUMMARY TABLE
DEDICATED LABORATORY VS. RESEARCH CAPABILITY

			DED	CATI	ED LA	BS
TIME-PHASED RESEARCH REQUIREMENTS	IA	IIA	ША	пв	пс	шв
BIOMEDICINE - MAN					<u> </u>	
Vestibular	x	x	x		1	
Cardiovascular	x	x	x	x	x	x
Pulmonary	х	х	х		•	
Biochemical Reactions	x	x	x			
Musculoskeletal	x	x	x	; X	x	x
Hematology	x	x	x			
Psychomotor Perf.	x	x	x		1	
BIOMEDICINE - ANIMALS				i i		
Vestibular	x	х	x	x	×	x
Cardiovascular	x	x	x	x	ж	x
Pulmonary	x	x	x	x	х	x
Biochemical	x	ж	$\mathbf{x} \mid \mathbf{x}$	x	x	x
Musculoskeletał	x	х	х	x	x	x
Hematology BIOLOGY	x	х.	х	X	ж	х
Higher Vertebrates	4*	52	2	2	2	
Lower Vertebrates	16*	16	32	16	16	32
Cellular & Molecular	x	х	х	x		
Invertebrate		х	х	x	}	
Plant		х	х	x		
Radiobiology		ж	х	x		
Microbiology	- 1	ж	x	x		
MAN-SYSTEMS INTEGRATION	ļ			ļ		
MSI Testing		х	x	I	1	
LIFE SUPPORT/PROTECTIVE SYSTEMS	•]		:		
Life Support Hardware Test		х	х	[
Zero-g Effects		x	x			

^{*}Indicates number of animals aboard.

DEDICATED LABORATORY MOD IA SCIENCE RATIONALE & RESEARCH CAPABILITY

SCIENCE RATIONALE

Dedicated Lab MOD IA is a 7-day, biomedical emphasis mission for the Shuttle/Spacelab. Man-related studies will be undertaken from two distinct, though related, orientations:

A. As a human organism requiring scientific investigation and measurement:

To understand the mechanisms of man's responses to space flight and his capability to adapt to the space environment. Special emphasis will be placed on those organ systems which have been found from previous flights to be influenced by gravity, e.g., cardiovascular, vestibular, and musculo-skeletal systems. Biological periodicities will be examined within the limits of mission profiles.

Animal models will provide information concerning basic mechanisms not easily determined in man. Such animal models would provide information in areas where measurements have not been developed for use in humans or would carry a significant hazard if utilized in man.

B. As an important (human) element of a flight system whose total performance capability is reflected in the performance level of that (human) system, and whose safety is of primary concern in any manned system:

To acquire, analyze, and interject data relevant to the problems of human performance, capability and behavior in space. This includes both group and individual behavior, attitudes, motivational levels, anxieties, etc.

To establish operator capabilities and requirements as they impact total system performance and crew safety.

To collect high fidelity, high quality data on the new population of space flight participants in order to substantiate and improve on the original medical selection criteria for Shuttle passengers and crews.

RESEARCH CAPABILITY SYNOPSIS - Area/Functions/Measurements/Major Equipment

nausea. Urine sample collection and analysis.

A. BIOMEDICAL - Man

1. Vestibular

Investigate role of visual cues in space nausea. Repeat of Skylab M131 experiment. Rotating Litter Chair. Role of altered body fluid volume, pressure and distribution to space

2. Cardiovascular

Altered vascular flow, volume & pressure relationships in zero-g. LBNP, VCG.

Demonstrate presence or absence of Gauer-Henry reflex. Early mission urine/blood sample collection and analysis. APE, Freezers. Regulation responses to exercise in zero-g. VCG, Human Phys. Kit, Exercise Eqmt.

3. Pulmonary

Altered pulmonary volume/flow/relationships in zero-g. Cardiopul-monay Analyzer, Exercise Eqmt.

4. Musculoskeletal

Exercise effect upon musculoskeletal derangement. Exercise physiology equipment, human physiology kit, ECG/VCG.

Diet and pharmacological control of musculoskeletal derangement. Food/fluid input records, feces/urine/vomitus collection/storage.

5. Hematology

Collect, prepare & preserve blood samples. Determine red cell mass, recitulocyte counts, pCO₂, pO₂, pH, enzymes, proteins, etc.

6. Microbiology

Effects of space environment upon host defense mechanisms. Microbial sampling, culturing, staining, examination. Incubator, staining system, microscopy.

7. Crew Performance in Space

Time and motion studies, training tasks. Time relate performance measures with daily activity schedules, sleep patterns, environmental conditions and biomedical measurements.

8. Effects of Training Upon Crew Efficiency

Correlate crew performance efficiency measurements with same tasks conducted in ground based simulators or prior missions.

B. BIOMEDICAL - Man Surrogate

To permit detailed invasive and statistical studies in the biomedical areas mentioned above, this laboratory contains the holding facilities, support equipment and monitoring instrumentation for the following populations:

Prima tes - 4 Holding units (1 primate each)

Small vertebrates - 2 Holding units (16 rats, hamsters, etc.)

Cells/Tissues - 2 Holding units

C. SUPPORTIVE SERVICES

Microscopy - Compound microscope for dark field, bright field, phase contrast.

Dissecting microscope. Microscope accessory kit includes polarizing equipment, filters, photographic and video attachments.

Photography - Cine film, 35 mm, polaroid.

Visual Records - Strip chart recorder (2-channel), digital display, oscilloscope, CRT/camera.

Preservation - Cryogenic freezer (quick-freeze), -70° & -20°C freezers, 4°C refrigerator.

Mass Measurement - Human mass device, macro mass measurement device (5 g to 2 kg) and micro mass measurement device (1 mg to 5 g).

LOAD	MOD	

EI	Name	Q	Unit Wt. kg	Unit Pwr. w	Unit Yol.
103		2	13.5	9	188
	THOUGHT ATTO	1	5	5	<u>.</u>
155	KTT, CHEMICAL	1	1.5	<u> </u>	5
	ALL MERVIORDER THE RESPORT	1	. 5 _		5
	KIT, CLEANIP	1	1.5	9	•
102	KIT, HISTOLOGY	1	1	0	1
	KIT, LIMEAR MEAS.		1	3	1
	KIT, MICHGAIDEDGY	\$	2	0	3
	KIT, HIVAH PHYSICEGY	1		3	8
	KIT, DISSECTION	1	1	0	2"
	FIT, VERTEBRATE MANAGEMENT	1	3	. 3	6
	KIL! AESAEBSTA SHAZIOFGZA	1	3	9	6
	LAMP, FORTABLE HI INT. EHOTO	1	6 <u>-</u> 3	150	6
1145	LIDUID STOP. AND DISPENS. SYS.	1	13	0	18
116	LOG BOOKS	3	5.5	0	8 - 4
117		1	78.7	2.6	2373
	MANIFULD, VACUUM	• 1	9.1	3	25.3
:21	MARS MEAR REVICE, MACRE	1	11.5	15	32.8
	MASS MEAS. DEVICE, MIGPO	1	12	15	25
124	ALUIT' BEEBYSEN	2	0.45	9	0.5
124	HIGPOSCOPE, COMPOUND	1	11	15	27.4
1254	HICPOSCOFF, SIRSFOTING	1	9	1 00	29
1263	HIGP. ACCESS. KII, COMPHR	. 1.	10	15	25
	NON-VISUAL DIRECTION INDICATOR	1	4-1	3	2.3
132.	ODDILLOSCOPE AND CAMERA	1	11.7	75	28.9
37	OTOLITH TEST GOGGLES	1	0.2	0	2.8
1360	BADED, RECODMING	ī	J.6	3	1-2
3.5	PH METER	1	1.6	20	5.2
4 3 6 7	PHOTOCELL COUPLED	12	0.2	Ž [*]	0.5
	PHYSICL. MULTICHEN. SENS SYS.		0.2	Š	1.4
	SUFTHYSMOGRAPH, LINS	Ť	2.4	5	6
	PHONEYTREADAPTTOSPA4 COUPLER	1	2.2	1	0.3
	PLHARING	· •	20	2	15
	SOESSIPE CONPLER	Ē	5.3	,	Č.5
	PAGIATION TETECTOR, DOSIM.	7	0.3	ס	ð.5
147	· · · · · · · · · · · · · · · · · · ·	•	15	50	20
	- JeCobbeo* diola CHVoi		T		15.9
		*	11.5	3 10	7003
	PECETVER, SIDTELEMETRY	4	0.5	10	•
	PROGRAFA, VOICE	1	***	4 73 79	239
	POTATING LITTER CHATR/CONSOLE	1	100.2	1 27	. 0.3
	SENSOPS, ASSOPTED	1	0.5	3	
	SISNAL CONDITIONERS (COUPLERS)	12	0.2	. 2	0.5
	PONC CAPRIOSPA4	1	19	32	59
177	SCHAD FEAST WELLS	1 1	13.6	ą	23.4
154	STAINING SYSTEM	1	2.2	j	3.5
	STEPILIZER, AUTGOLAVE	1	11	300	34.7
	STERTLIZER, TOOL	1	1 _	116	<u>1</u>
	TANK , VERTURDATE HATER	5	8.5	5	29.3
	THERMOCOUPLE INDIDATOR	1	6	Ą	9.4
	LEAFEDULISE BEOLK	1	4.5	255	1.7
	THERMODOLIPLES	1	€.5	D	C. 7
	THERMOMETER, PLECTRONIC	1	5.4	14	8.7
150	TIMER, EVENT	2	8.2	D	0.2
1817	LOUNCED DOEZENDE	4	3.2	1	0.4
162 1	VOS DOUPLEP	1	9.2	S	0.5
-	VENTILATION UNIT, VERT	5	19	4 0	32.7
	MILTIHETER	1	5	5	2.4
188	MOPK AND SUPGICAL BENCH	1	136	1000	423

	LOAD NO. MOD IA		Unit Wt.	Unit Pwr.	Unit Yol.
EI	Nam e	ବ	kg	w	dm ³
1	SCOPURECHEFER	₹	C-1	0	1.13
1 1	ACCERBONETED CONFLER	₹ '	9-55	1	5.11
6 ,	STR RARTICLE SAMELIN	1	2.7	5.0	£ * 42
¢Δ	ATHREON HORK SUPPACE	1.	5	75	, f i
7	ANTOANALY FFE (GCHSAFC)	1	25	5.00	4.5
	AUTO POTENTIO. PLEC. ANAL.	. 1	12.7	1.00	57
	SUTENNAS, ASSOPTED	. 1	0.1	9_	C 03
	ATHOS. SAMPLING SYSTEM	1	10_	20	2.5
	AUNTOHETER	1	4.5	25	4.3
	SINGTO, PARTATION	2	2.2	y	0-1
	CUCTON SITE BOARDS	1	0-1	1	6.03
	ENSTOM BITE BOARDS		0.23 36.5	15	675
	COLONY CHAMPER, SEALABLE	20	0.2	Ď.	0.1
	CASE, RAY, HANSTER, STANDARD	16	2.3	a '	11
7.	CALCULATOR, PURKET	. 1	8.47	á	0.4
	CA4FRA, CINE	ī	5	13	5
	CA ISPA CONTROLLER	<u> </u>	13.6	100	28.3
	Charas, Folkaoto	· • •	3.3	3	5.6
	CARTRA, 35 MM AND STROBE	. 1	2	0	2
37	GAMERA, VIOCO, SVW	2	4.4	15	3
3.8	CAMERA, VINEO, COLOR	1	7.7	69	6. ?
	STALBY MONALA	1	3	0	3
357	CAMED TIMES, VIDEO	1	4	13	3
	PART TOPULMONARY ANALYZER	1	9 <u>0. 7</u>	200	172
	CENTRIFICE. BUT SHPU PROCESSOR	1	12.7	166	25
44		1	0.5	ō	1.0
	CHEMICALS, PADIOTSOT. TPACEPS	1	C-3	9	0.5
45	SHEWIGAL STOPAGE CABINET	1	4.0	0	14-1
	CLEANER, VACHIM	1	2.3	106	10
	CLINOSTAT (FOR C/T)	1 '	2 18	10 190	113
707 640	COMPACTOR: SOLIDS CONTROL CONSOLE: EXPERIMENTER	†	22.7	106	113.3
	CODLANT LOCP, LICUIT	i	30	50	25
	COUNTER COLONY, MANUAL	•	1.5	50	1.5
	HISPLAY KEYSCAPD, POPTABLE	ī	13.6	63	42.5
	TISPLAY. NUMERIC	Ž	2	2 .	4
54		12	0.2	2	G.5
. 65	FFG COUPLER	. 4	6.5	2	. 0.5
653	FLFCTPOPHYS. BACKPACK	1	0.3	Ď.	0.23
	FLFC TROPHYS. RFCFIVER	1	2.7	25	5.0
	cad Contrib	-6	0.2	2	0.5
7 ^ (FOULPHENT PESTPAINT DEVICE	1	C.5	. 1 5	1
	EVERCISE EDUTE., PHYSIOL.	1	C.5 96 0.54 0.16 0.13 0.5 21.6	16	992
750	FILM, CINE FILM, FOLAROTO FILM, 35 MM	<u> </u>	0.54	U 0	6.54
755	FIEM, POLARUIN		0 4 7	0	0.13 C.05
77.1	riung as no Crowneres	10	5.E		6.5
773 773	FILM, 35 MM FLOWMETERS FREEZER, OPYSGENIC	-	21.6	10	
9.5	FORTER GENERAL	•	15	200	61.4
8.4	FORETED IN TEMP.	•	A	10	30.5
	FRIG. (REFRIGERATOR)	i	18	50	33.5 123
<u>41</u>	FORF ZFO, GENERAL FORETHE, GENERAL FOLG. (REFOLGERATOR) GAS ANALYZER, PH GAS SHERLIFS SLOVE BOX, FORMALE SLOVE BOX, LINERS	ž	25	5 G	20
ć۲	GAS ANALYZED. PH	1	5.2	5	17
G 7 A	SAS SUPPLIES	<u>-</u>	5.75	C C	17 13
06	SEOVE BOX, PORTARLE	1	4.5	3	25
ð. L	SLOVE ROX LINERS	10	0.5 0.3	9	1
970	HANDHIPES, BETADANE	19	6.3	· ā	
è e V	HOLDING UNIT, PELLS/TISSUES	Ş ·	23	30	
1017	HOLDING UNIT, PRIMATE	4	113	100	343

DEDICATED LABORATORY MOD IIA SCIENCE RATIONALE & RESEARCH CAPABILITY

SCIENCE RATIONALE

Dedicated Lab MOD IIA is a 7-day biomedical/biology/advanced technology emphasis mission for Shuttle/Spacelab.

- A. Man-related studies will be undertaken from two distinct, though related, orientations:
 - 1. As a hunan organism requiring scientific investigation and measurement:

To understand the mechanisms of man's responses to space flight and his capability to adapt to the space environment. Special emphasis will be placed on those organ systems which have been found from previous flights to be influenced by gravity, e.g., cardiovascular, vestibular, and musculo-skeletal systems. Biological periodicities will be examined within the limits of mission profiles. Animal models will provide information concerning basic mechanisms not easily determined in man. Such animal models would provide information in areas where measurements have not been developed for use in humans or would carry a significant hazard if utilized in man.

2. As an important (human element of a flight system whose total performance capability is reflected in the performance level of that (human) system, and whose safety is of primary concern in any manned system:

To acquire, analyze, and interject data relevant to the problems of human performance, capability and behavior in space. This includes both group and individual behavior, attitudes, motivational levels, anxieties, etc.

To establish operator capabilities and requirements as they impact total system performance and crew safety.

To collect high fidelity, high quality data on the new population of space flight participants in order to substantiate and improve on the original medical selection criteria for Shuttle passengers and crews.

B. Although animals, as biological species, will be used as models for manrelated studies, the term Space Biology encompasses research on a wide variety of biological materials ranging from cells to complex multi-cellular animals. Major objectives of the Space Biology program are: To advance our knowledge of the role of gravity in the life processes and the capability of terrestrial organisms to adapt to gravitational changes.

To understand the basic nature of biological rhythms in terrestrial organisms and their influence on life processes.

To determine and assess the biological implications of galactic cosmic HZE particles for developing realistic radiation exposure guidelines and providing protective and/or preventive measures against particle radiation hazards for long duration space missions.

To determine the potential applications and to develop the techniques to utilize new advances in biological theories and space technology gained from research in the unique environment of space for space exploration and for the benefit of mankind. This includes cross-utilization of information between scientific disciplines, especially by means of flight experiments of mutual interest and/or applicability to different disciplines.

To assess the possible synergistic effects of gravity, magnetism and radiation on life-s origin and evolutionary processes.

C. Advanced technology research goals and objectives to be accomplished include but are not limited to:

Continuing advanced technology research on life support, protective systems, and work aids to provide as near an Earth atmospheric environment for man as possible; to provide him with protection from hazards of the space environment, optimize his ability to work in space and to maintain his health. Special emphasis will be placed on areas such as:

Development of regenerative life support systems including bioregenerative systems and new principles of membrane transport and related phenomena, development of advanced protective devices for manned space flight.

Measurement of man's performance in EVA, evaluation and validation of principles of system design and man-machine integration.

Demonstration and flight evaluation of teleoperator technology; e.g., visual environment sensors and displays, man-machine capabilities and acquisition of an experience and engineering data base.

RESEARCH CAPABILITY SYNOPSIS - Area/Functions/Measurements/Major Equipment

A. BIOMEDICAL - Man

1. Vestibular

Investigate role of visual cues in space nausea. Repeat of Skylab M131 experiment. Rotating Litter Chair.

Role of altered body fluid volume, pressure and distribution to space nausea. Urine sample collection and analysis.

2. Cardiovascular

Altered vascular flow, volume and pressure relationships in zero-g. LBNP, VCG.

Demonstrate presence or absence of Gauer-Henry reflex. Early mission urine/blood sample collection and analysis. APE, Freezers. Regulator responses to exercise in zero-g. VCG, Human Phys. Kit, Exercise Eqmt.

3. Pulmonary

Altered pulmonary volume/flow/relationships in zero-g. Cardiopulmonary Analyzer, Exercise Eqmt.

4. Musculoskeletal

Exercise effect upon musculoskeletal derangement. Exercise physiology equipment, human physiology kit, ECG/VCG.

Diet and pharmacological control of musculoskeletal derangement.

Food/fluid input records, feces/urine/vomitus collection/storage.

5. Hematology

Collect, prepare and preserve blood samples. Determine red cell mass, reticulocyte counts, pCO₂, pO₂, pH, enzymes, proteins, etc.

6. Microbiology

Effects of space environment upon host defense mechanisms. Microbial sampling, culturing, staining, examination. Incubator, staining system, microscopy.

7. Crew Performance in Space

Time and motion studies, training tasks. Time-relate performance measures with daily activity schedules, sleep patterns, environmental conditions and biomedical measurements.

8. Effects of Training Upon Crew Efficiency

Correlate crew performance efficiency measurements with same tasks conducted in ground based simulators or prior missions.

B. <u>BIOMEDICAL</u> - Man-Surrogate

To permit detailed invasive and statistical studies in the biomedical areas mentioned above. This laboratory contains the holding facilities, support equipment and monitoring instrumentation for the following populations:

Primates - 5 Holding units (1 primate each)

Small vertebrates - 2 Holding units (16 rats, hamsters, etc.)

Cells/Tissues - 2 Holding units

C. SPACE BIOLOGY

The holding units mentioned in "B" above, besides supporting man-surrogate research, will support space biology research. Additional holding units are:

Plants - 2 Holding units

Invertebrates - 2 Holding units

1. Cellular & Molecular Biology

Density dependent growth/development processes. Wound repair rates, membrain electrolyte transport.

Generic alterations in zero-g. Cell metosis, chromosome aberrations, cell divisions.

2. Lower Vertebrate Biology

Basic mechanisms of physiological adaptation, growth, development and reproduction in zero-g. Circadian rhythm studies. Metabolic monitoring, physiological monitoring, histological preparations, surgery, environmental monitoring.

3. Higher Vertebrate Biology

Invasive studies of the physiological systems as described under "A" above.

4. Invertebrate Biology

Basic mechanisms of physiological adaptation, growth, development & reproduction in zero-g. Complete life cycle studies. Monitor behavior patterns, activity cycles, growth rates, morphology. Histological preparations.

5. Plant Biology

Study basic mechanisms of growth, development and reproduction in zero-g. Geotropism, morphology, photosynthetic activity, productivity.

6. Radiobiology

Biological effects of HZE particle irradiation. HZE particle detection. Exposure of small animals, plants, tissue cultures to HZE radiation.

D. ADVANCED TECHNOLOGY

1. Life Support Hardware Testing in Zero G

Test condensers, vapor cycle units, sterilizers, ${\rm CO_2}$ reduction units, biopacks, pressure suits. Life Support Test Console.

2. Effects of Space Inertial Forces on Gravity Sensitive Processes

Examine mixed phased flows, mixing, heat transfer characteristics. Use PI developed hardware test apparatus.

3. Man-Machine Testing of Advanced Designs

Measure man's performance in EVA, systems design, etc. Use psychomotor performance console, Spacelab CRT/keyboard, etc. Evaluate Teleoperator technology.

E. SUPPORTIVE SERVICES

- Microscopy Compound microscope for dark field, brightfield, phase contrast.

 Dissecting microscope. Microscope accessory kit includes polarizing equipment, filters, photographic and video attachments.
- Photography Cine film, 35 mm, polaroid.
- Visual Records Strip chart recorder (2-channel), digital display oscilloscope, CRT/camera.
- Preservation Cryogenic freezer (quick-freezer), -70° & -20°C freezers, 4°C refrigerator.
- Mass Measurement Human mass device, macro mass measurement device (5 g to 2 kg) and micro mass measurement device (1 mg to 5 g).

PAYLOAD NO. MOD IIA

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 / ₂ 10	A A A A A A A A A A A A A A A A A A A	0	Unit Wt.	Unit Pwr.	Unit Vol.
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## 11 PARTYTH SAMPLED ## 12 PARTYTH SAMPLED ## 13 PARTYTH SAMPLED ## 14 PARTYTH SAMPLED ## 15 PARTYTH SAMPLED	_					9.23
6 A 13-FLOW HORN SIPPLOF 7 A MITD ADMINITED (SERVARE) 7 A MITD ADMINITED (SERVARE) 1			7		1	0.11
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180 CUSTOM BITE GGAPOS 190 PATY MASS WESS, SEVICE 100 PATY MASS WESS, SEVIC	150	RADGES, PADIATION	2	0.2	Û	€.1
199 3079 MASS MESS STUTCF 1 36.5 15 67 25 CASE, INVERTEDATES 40 C.3 0 C. 257 CASE, INVERTEDATES 40 C.3 0 C. 257 CASE, MINVERTEDATES 7 CALASLE 77 3C 7. 25 CASE, METABOLTO, PLANT 7 7 3C 7. 25 CASE, METABOLTO, PLANT 7 7 3C 7. 26 CASE, PAT, MAMEREP, STANDARD 16 2.3 9 11 27 CALCULATOR, POCKET 1 D.47 3 0. 27 CAMERA, CIME 1 5 13.6 10C 28 27 CAMERA, CIME 1 5 13.6 10C 28 27 CAMERA, POLARCTO 1 3.3 D 5. 27 CAMERA, POLARCTO 1 3.3 D 5. 27 CAMERA, POLARCTO 1 3.3 D 5. 28 CAMERA, MINTO, STANDARD 1 2 0 2 29 CAMERA MOUNTS 1 3 0 3 27 CAMERA MOUNTS 1 3 0 3 28 CAMERA MOUNTS 1 3 0 3 28 CAMERA MOUNTS 1 3 0 3 28 CAMERA MOUNTS 1 3 0 3 28 CAMERA MOUNTS 1 3 0 3 28 CAMERA MOUNTS 1 3 0 3 29 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 3 0 3 20 CAMERA MOUNTS 1 1 4 16 20 CAMERAL STOPASE CABINET 1 4.0 0 14 20 CHENICALS MOUNTS 1 1 2.0 0 14 20 CHENICALS MOUNTS 1 12 20 CHENICALS MOUNTS 1 12 20 CHENICALS MOUNTS 1 12	16F	BALLISTOGARMIOSPAM COUPLER	1	0.1	1.	1
25 CASE, INVESTREDATES	180	CUSTOM BITE GGARDS	1	0.23	9	0.93
253 CJUAY CHAMSES, STALBLE 23 0.2 0 C. 253 CIGE, FFIABOLIO, PLANT 2 4.5 3 50 254 CAGE, PLANT 2 4.5 3 50 374 CAGE, PLANT 2 4.5 3 50 374 CAGE, PLANT 2 4.5 3 50 374 CAGE, PLANT 2 4.5 3 51 374 CAGE, PAT, MASSER, STANDARD 16 2.3 9 11 374 CALCULATO, MASSER 51 10.47 3 0.47 375 CAMERA, CIME 1 5 13 5 376 CAMERA, CIME 1 5 13 5 377 CAMERA, FOLARCID 1 13.6 10C 28 377 CAMERA, FOLARCID 1 13.6 10C 28 377 CAMERA, FOLARCID 1 2 0 2 378 CAMERA, FOLARCID 1 3.3 0 5. 379 CAMERA, VINEO, 2/M 2 4.4 15 3 379 CAMERA MOINTS 1 3 0 3 379 CAMERA MOINTS 1 3 0 3 379 CAMERA MOINTS 1 3 0 3 379 CAMERA MOINTS 1 3 0 3 379 CAMERA MOINTS 1 3 0 3 379 CAMERA MOINTS 1 3 0 3 379 CAMERA MOINTS 1 4 16 3 370 CAMERA MOINTS 1 4 16 3 370 CAMERA MOINTS 1 4 16 3 370 CAMERA MOINTS 1 4 16 3 370 CAMERA MOINTS 1 10 50.7 10C 25 44 CHEMICALS, RADICISOT. TRACEPS 2 0.3 3 0.45 45 CHEMICALS STORAGE CABINET 1 4.0 0 14 46 CLEANER, MACHIMM 1 2.0 1 10 47 CHEMICALS STORAGE CABINET 1 4.0 0 14 47 CHEMICALS STORAGE CABINET 1 4.0 0 14 48 CLEANER, MACHIMM 1 2.0 1 10 510 CLINOSTAT (FOR PLANTS) 1 3 10 511 COULART (FOR PLANTS) 1 3 10 512 COMPACTOR, SOLINS 1 18 10 514 COULART (FOR PLANTS) 1 3 10 515 COUNTER, EXPERIMENTER 1 22.7 100 516 COUNTER, EXPERIMENTER 1 22.7 100 517 COULART KEVROLARD, PORTABLE 1 13.5 50 51 COUNTER, NUMERIC 2 2 4 52 COUNTER, SACKMACK 1 0.3 0 0.5 54 COUNTER, SACKMACK 1 0.3 0 0.5 55 COUNTER, SACKMACK 1 0.3 0 0.5 56 CEG COUNTER 57 CHECTOCHAPS, BACKMACK 1 0.3 0 0.5 57 CT TILL, CINE 4 0.5 0 0.5 57 CT TILL, CINE 4 0.5 0 0.5 57 CT TILL, CINE 4 0.5 0 0.5 57 CT TILL, CINE 4 0.5 0 0.5 57 CT TILL, CINE 4 0.5 0 0.5 57 CT TILL, CINE 4 0.5 0 0.5 57 CT TILL, CINE 4 0.5 0 0.5 57 CT TILL, CINE 5 0.5 1 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 CT TILL, CINE 5 0.5 1 0.5 57 CT TILL, CINE 5 0.5 1 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 COUNTERS SOURCE 1 0.5 0.5 57 CO	197	- ROOM MASS MEASS DEVICE	1	36.5	15	675
263 CAGE, FITABOLTC, PLANT 20 CAGE, PLANT 21 CAGE, PLANT 22 CAGE, PLANT 23 CAGE, PLANT 24 CAGE, PLANT 25 CAGE, POT, MAKETER, STANDARD 16 2.3 3 11 71 CALCULATOR, POCKET 1	25	CASE, INVERTERRATES	4.9	£.3	9	0.2
263 CAGE, FITABOLTC, PLANT 20 CAGE, PLANT 21 CAGE, PLANT 22 CAGE, PLANT 23 CAGE, PLANT 24 CAGE, PLANT 25 CAGE, POT, MAKETER, STANDARD 16 2.3 3 11 71 CALCULATOR, POCKET 1	257	COLUNY CHAMBER, SEALABLE	53	0.2	O	C.1
364 CASE, PAT, HAMSTER, STANDARD 16 2.3 9 11 71 CALCULATOR, POCKEY 1 0.47 0 0.47 1 0.4			2	7	3 C	74.6
364 CASE, PAT, HAMSTER, STANDARD 16 2.3 9 11 71 CALCULATOR, POCKEY 1 0.47 0 0.47 1 0.4	20	DAGE. PLANT	2	4.5	3	56.6
71 GALGULATOR, POCKET 32 GA197A, CIMP 32 GA197A, CIMP 33 GA197A, COMPOLLED 37 CA197A, POLAGGIP 38 GA197A, POLAGGIP 38 GA197A, POLAGGIP 38 GA197A, VINFO, 27M 39 GA197A, VINFO, 27M 30 GA197A, VINFO, 27M 31 GA197A, VINFO, 27M 32 GA197A, VINFO, 27M 33 GA197A, VINFO, 27M 34 GA197A, VINFO, COLOP 37 GA197A, VINFO, COLOP 38 GA197A, VINFO, COLOP 38 GA197A, VINFO, COLOP 39 GA197A, VINFO, COLOP 39 GA197A, VINFO, COLOP 30 GA197A, VINFO, COLOP 30 GA197A, VINFO, COLOP 30 GA197A, VINFO, COLOP 31 GA197A, VINFO, COLOP 44 GA197A, VINFO, CANANA 45 GA197A, VINFO, CANANA 46 GA197A, VINFO, CANANA 47 GA197A, VINFO, CANANA 48 GA197A, VINFO, CANANA 49 GA197A, VINFO, CANANA 50 GA197A, VINFO, CANANA 51 GA197A, VINFO, CANANA 51 GA197A, VINFO, CANANA 52 GA197A, VINFO, CANANA 53 GA197A, VINFO, CANANA 54 GA197A, VINFO, CANANA 55 GA197A, VINFO, CANANA 56 GA197A, VINFO, CANANA 57 GA197A, VINFO, CANANA 58 GA197A, VINFO, CANANA 59 GA197A, VINFO, CANANA 50 GA197A, VINFO, CANANA 51 GA197A, VINFO, CANANA 52 GA197A, VINFO, CANANA 53 GA197A, VINFO, CANANA 54 GA197A, VINFO, CANANA 55 GA197A, VINFO, CANANA 56 GA197A, VINFO, CANANA 57 GA197A, CANANA	304		15	Ž. 3		11
22 CA4EPA, CIÚE 23 CA4EPA GONTODLED 24 CA4EPA, POLÁRGIN 25 CA4EPA, POLÁRGIN 26 CA4EPA, VIDEO, PIM 27 CA4EPA, VIDEO, PIM 28 CA4EPA, VIDEO, COLOD 29 CA4EPA VIDEO, COLOD 20 CA4EPA VIDEO, COLOD 27 CA4EPA VIDEO, COLOD 28 CA4EPA VIDEO 28 CA4EPA VIDEO 28 CA4EPA VIDEO 28 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 29 CA4EPA VIDEO 20 CA4EPA 20 CA			1			0.4
724 CAMEPA CONTROLLED 37 CAMEPA, POLARCTD 1 3.3 D 38 CAMEPA, 75 MM AND STPCSF 1 2 0 2 2 37 CAMEPA, VIDEO, 274 2 4.4 15 3 3 6 3 5 6 6 3 6 6 6 6 6 6 6 6 6 6 6	_	The state of the s	1		- · · · · · · · · · · · · · · · · · · ·	
37 CAMERA, POLARCTR 76 CAMERA, 75 MM AND STROST 77 CAMERA, VIDEO, 27M 78 CAMERA, VIDEO, 27M 78 CAMERA, VIDEO, 27M 78 CAMERA, VIDEO, 27M 78 CAMERA VIDEO, 27M 78 CAMERA VIDEO, 27M 78 CAMERA VIDEO, 27M 78 CAMERA VIDEO, 27M 78 CAMERA MOINTS			ī			28.3
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77 CAMERA, VIDEO, 27M 28 CAMERA, VIDEO, COLOR 38 CAMERA MOUNTS 1 3 0 3 760 CAMERA TIMER, VIDEO 1 4 16 3 736 CAMORA TIMER, VIDEO 1 4 16 3 736 CAMORA TIMER, VIDEO 1 4 16 3 736 CAMORA TIMER, VIDEO 1 40 16 3 736 CAMORA TIMER, VIDEO 1 50.7 200 17 400 CHANTOALS 1 2.7 100 25 44 CHAMICALS 44 CHAMICALS 44 CHAMICALS 45 CHAMICALS 46 CHAMICALS 47 CHAMICALS 48 CHEMICALS 48 CHEMICALS 49 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 41 CHOMICALS 41 CHAMICALS 42 CHAMICALS 43 106 11 44 CHEMICALS 45 CHAMICALS 46 CHEMICALS 47 CHAMICALS 48 CHEMICALS 48 CHEMICALS 49 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 41 CHAMICALS 41 CHAMICALS 41 CHAMICALS 41 CHAMICALS 42 CHAMICALS 44 CHAMICALS 45 CHAMICALS 46 CHAMICALS 47 CHAMICALS 47 CHAMICALS 48 CHAMICALS 48 CHAMICALS 49 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 40 CHAMICALS 41 CHAMICALS 41 CHAMICALS 41 CHAMICALS 41 CHAMICALS 42 CHAMICALS 43 CHAMICALS 44 CHAMICALS 45 CHAMICALS 45 CHAMICALS 46 CHAMICALS 46 CHAMICALS 46 CHAMICALS 47 CHAMICALS			ī			
### RAMERA, VINEO, COLOR			5		T	
38° CAMERA MOUNTS			•			6.2
30 1 4 1 6 3 3 3 6 3 3 3 6 6			î	3		
### CAPTIONIL 10NAPY 10ALYTER ####################################			- 1	ĭ	'	
### CTNTPIFUGE, BED SIPE PROCESSOR #### CHEMICALS #### CHEMICALS #### CHEMICALS #### CHEMICAL STORAGE CABINET #### CHEMICAL STORAGE CABINET ##### ###############################		•	1	96.7		172
44 GHEMICALS RADICISOT. TPACFOS 2 C.3 3 0.4 CHEMICALS RADICISOT. TPACFOS 2 C.3 3 0.4 C.5 CHEMICAL STOPAGE CABINET 1 4.0 0 0 14 C.5 CHEMICAL STOPAGE CABINET 1 4.0 0 0 14 C.5 CHEMICAL STOPAGE CABINET 1 2.3 18G 13 5C CLINOSTAT (FOP PLANTS) 1 3 10 20 5C CLINOSTAT (FOP PLANTS) 1 3 10 20 5C CLINOSTAT (FOP PLANTS) 1 2 10 4 5C CLINOSTAT (FOP PLANTS) 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			•		- 1.5	
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45 CHMICAL STOPASE CABINET 46 CLEANER, VACUUM 57 CLINOSTAT (FOR PLANTS) 51 CLINOSTAT (FOR PLANTS) 52 CLINOSTAT (FOR CAT) 52 COMPACTOR, SOLTOS 51 12 10 4 52 COMPACTOR, SOLTOS 51 18 180 11 510 COMPACTOR, SOLTOS 51 18 180 11 510 COMPACTOR, SOLTOS 51 18 180 11 510 COMPACTOR, SOLTOS 51 18 180 11 510 COMPACTOR, COLONY, MANUAL 51 COUNTER, COLONY, MANUAL 52 COUNTER, COLONY, MANUAL 53 COUNTER, COLONY, MANUAL 54 COUNTER, COLONY, MANUAL 55 COUNTER, COLONY, MANUAL 56 COLOUPLER 56 COLOUPLER 56 COLOUPLER 56 COLOUPLER 56 COLOUPLER 56 COLOUPLER 56 COLOUPLER 56 COLOUPLER 56 COLOUPLER 57 CLECTPORPHYS. PECFIVER 58 COLOUPLER 59 COLOUPLER 50 COLOUPLER 50 COLOUPLER 50 COLOUPLER 51 COLOUPLER 52 COLOUPLER 53 COLOUPLER 54 COLOUPLER 55 COLOUPLER 56 COLOUPLER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 50 COLOUPLER 50 COLOUPLER 50 COLOUPLER 50 COLOUPLER 51 COLOUPLER 52 COLOUPLER 53 COLOUPLER 54 COLOUPLER 55 COLOUPLER 56 COLOUPLER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 58 COLOUPLER 59 COLOUPLER 50 COLOUPLER 50 COLOUPLER 50 COLOUPLER 50 COLOUPLER 51 COLOUPLER 52 COLOUPLER 53 COLOUPLER 54 COLOUPLER 55 COLOUPLER 56 COLOUPLER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 50 COLOUPLER 50 COLOUPLER 50 COLOUPLER 50 COLOUPLER 51 COLOUPLER 52 COLOUPLER 52 COLOUPLER 53 COLOUPLER 54 COLOUPLER 55 COLOUPLER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 50 COLOUPLER 51 COLOUPLER 52 CLECTPORPHYS. PECFIVER 51 COLOUPLER 52 CLECTPORPHYS. PECFIVER 52 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 57 CLECTPORPHYS. PECFIVER 58 CLECTPORPHYS. PECFIVER 59 CLECTPORPHYS. PECFIVER 50 CLECTPORPHYS. PECFIVER 50 CLECTPORPHYS. PECFIVER 51 CLECTPORPHYS. PECFIVER 51 CLECTPORPHYS. PECFIVER 52 CLECTPORPHYS. PECFIVER 51 CLECTPORPHYS. PECFIVER 51 CLECTPORPHYS. PECFIVER 51 CLECTPORPHYS. PECFIVER 51 CLECTPORPHYS. PECFIVER 51 CLECTPORPHYS			9			9.5
### CLEANFP, VACUITY 5C CLINOSTAT (FOP CLANTS) 5CA CLINOSTAT (FOP CLANTS) 5CA CLINOSTAT (FOP CLT) 5CR COMFACTOP, SOLIDS 5CR COMFACTOP, SOLIDS 5CR COMFACTOP, SOLIDS 5CR COMFACTOP, SOLIDS 5CR COMFACTOP, SOLIDS 5CR COMFACTOP, EXPEPIMENTER 1	. 45	CHEMICAL STORES CARTNET			_	14.1
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54 COUNTER, COLONY, MANUAL 1 1.5 50 1.67		•				
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760 FTLM, 25 MM 10 0.13 0 0.17 10 0.18	750	tilm, Lint		0.54	J	£.74
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er FREEZER, GENERAL 2 15 200 61	76.)	FLOWMETERS	27	U . 7	1	0.5
er FREEZEP, GENERAL 2 15 200 51	770	EPER ZEE, SPYOSENIC	1	21.6	10	74.1
			2	15		51.4
CI TIPEASTS GUM ISHES	£1	FORFIER, LOW TEMP.	1,	8	10	33.5
67 FRIG. (REFRIGERATOR) 2 18 50 18	6.7	ESIG* (KEEKIGESTANDA)	2	15	50	129

PAYLOAD NO. MOD IIA

			Unit Wt.	Unit Pwr.	Unit Vol.
ΕI	Name	Q	kg	w	$ m dm^3$
- 2	CAS AMALYPED, THERAPER	1.	11.3	50	1.2 6
61	GAT ANALYTER, MASS SPEC.	,	. 25	53	42.6 23
c *		1	5.2	5	13
674	SET RIFFLIER	ĸ	5.75	. 5	18
Ç #	GLOVE SCX, PROTABLE	1	4.5	ž	25
CAP	GLOVE SOX FINES	23	5.5	7	1
570		2 2 2 5	0.3	ĵ	6.3
	HTLDING UNIT, TELLS/TISSUES	?	23	30	188
با قال	HOLD, INIT, INVESTESPATES	?	23	50	189.
	HOUDING HAIT, PLANT	2	25	SUC	133
	HOUSTING HAIT, PRIMATE	5	113	100	343
	HOUDING MAIT, SM. VERT.	a 🕴	13.6	· 3	18.5
	TIGURATOR	1	5_	5	
	MIT, CHEMICAL	1	1-5	0	5
	KIT, HEMATOLOGY AND UROLOGY	1	5 _	9	9
100	KIT, CLEANIP	1	1.5	Ď	•
125	KIT, HISTOLOGY	1	1	9	1
	KIT, LINGAP MGAS.	1	1	3	1
110		3 .	2	<u> </u>	3
	KIT, HUMAN PHYSIDLOSY	1	3	3	6
111	KIT, FLANT MANAGEMENT	1	1	IJ	1
	KIT, INVERT, MANAGEMENT KIT, DISSECTION	1	1	ű,	2
	KIT, VEGTERRATE MANAGEMENT	1	1 3	0	2
	MIT, VESTEBOATE SHYSIOLOGY	1	3	D	0
	LAME, FORTABLE HT INT. PHOTO	1	6.3	150	7 0
	LIQUIN STOP. AND DISPENS. SYS.	5	13	T	D 4.6
	LSS TEST CONSOLE.	- E	15	9 9	18 560
	LOG ROCKS	*	0.5	0	.0.6
	LOWER SORY WEG. PRESS. DEVICE	4	78.7	26	2373
	MANIFELD, VACUUM	1	9-1	Õ	28.3
	MSI TASK SIMULATOR	ī	22.7	Š	200
	MASS MEAS. DEVICE. MACRO	i	11.8	15	32.8
	MASS MEAS. DEVICE, MICRO	ī	12	1,5	25
	MASS, TEST, VAPTABLE SIZE	1	G	ā	Ō
124	MENIA, PREPAREM	2	0-45	3	C.5
126	MICHOSCOPE, COMPOSINO	1	11	1 5	27.4
1254	MICROSCOPE, DISSECTING	1	9 .	1 0	28
	YORILITY UNIT, PROT. CORRIDOR	1	22.7	9	56.6
1541	MICH. ACCESS. KIT, COMPNY	1	10	1 °	. 25
_	MOTOPITED PLANT SPONTH MONITOR	2	0.5	5	0.6
	NON-VISUAL DIRECTION INDICATOR	1	4-1	0	2.8
	DETISCAN - FIFLD AND FIXED	1	2-3	5	8.5
	DESTILLOSCOPE AND CAMERA	. 1	11.7	7 5	23.9
	CTOLITH TEST GOGGLES	1	0.2	0	2.8
	PARER, RECORMING	1	0.6	9	1.2
138	PH METER	1	1.5	20	5.2
1358	PHOTOCELL COMPLET	12		2	0.5
1.35=	PHYSICL. MULTICHAN. SENS SYS.	1	C • 2	0	1.4
139	PLETHYSHOGPARH, LIMB	1	2.4	5	6
146	PHONOVIERACARDIOGRAM COUPLER	1 1	0-5	1 2	0.3
	PLHMSING	1		2	15
	FORESTER COMPLER	4	5-3	2	0.5
	STYCHOMOTOR PERFORM. CONSOLE	1		15	10-3
, uu.	PARIATION RETERICS, DOSTM.	1	0.3	0	0.5
147	PARIATION CONSTER PECONORY STREET PART	1.	15	5.	20
1.71年	SECEIAES BIOLEFERESA	1	11.5	3 4 C	16.9
467	・ウェイト りりゅう しゅうてき こうしゅう	1	0.5	10	1
1678	POTATING LITTE SHAIR/SONFOLE		1 100 0	3 127	1 270
	SENSORS, ASSORTED	1	160.2 6.5		239
1.200	ு நாகுறுக்கு அவ்வமாறு இ	1	U = 7	9	0 + 3

PAYLOAD NO. MOD IIA

			Unit Wt.	Unit Pwr.	Unit Vol.	
EI	Name		kg	w	dm ³	
155	STORAL COUNTYTONES (COURLESS)	16	2.2	2	0.5	
1 FAF	TUNDO49710984 #	1	19	32	59	
	ROMAN LEVAL MATER	1	13.5	0	33.4	
1550	ROADESUIT TEST CONSOLE	1	75	5.0	<i>5</i> 3	
	STAINING SYSTEM	• 1	2.2	Q.	2.5	
	STEPILIZER, ANTOCLAVE	1	11	300	34.7	
	STEPILITER, TOOL	1	1	110	1	
172	S#4CFSUIT	1	36.3	1	198.2	
	TANK, VESTERPATE WATER	6	8.5	5	28.3	
175	TANK, PLANTITUEPT, WATER	2	1.7	Ò	3	
1764	TARKECARD, FORCE/TOPONE	1	22.7	5	56.6	
1769	THERMOCOUPLE THRECATOR	1	6	8	9.4	
179	TEMPERATURE BLOCK	1	4.5	200	1.7	
1798	THERMOCOUPLES	1	0.5	0	0.3	
1797	THERMOMETER, ELECTRONIC	1	5.4	14	3.7	
187	TIMER, EVENT	2	0.2	Đ	0.2	
1617	TPANSDUCER, PRESSURE	4	Ç - 2	1	C - 4	
	VOG COUPLER	1	9 - 2	2	0.5	
	VISION TESTER	1	22.7	130	113.3	
	VENTILATION UNIT, VERT.	6	. 19	43	32.7	
185	MINETINGTED	1	2	9 -	2.4	
1 & 3,	HORK AND SUPSIDAL BENCH	1	135	1900	423	

DEDICATED LABORATORY MOD IIIA SCIENCE RATIONALE & RESEARCH CAPABILITY

SCIENCE RATIONALE

Dedicated Lab MOD IIIA is a 30-day biomedical/biology/advanced technology emphasis mission for Shuttle/Spacelab.

- A. Man-related studies will be undertaken from two distinct, though related, orientations:
 - 1. As a human organism requiring scientific investigation and measurement:

To understand the mechanisms of man's responses to space flight and his capability to adapt to the space environment. Special emphasis will be placed on those organ systems which have been found from previous flights to be influenced by gravity, e.g., cardiovascular, vestibular, and musculo-skeletal systems. Biological periodicities will be examined within the limits of mission profiles. Animal models will provide information concerning basic mechanisms not easily determined in man. Such animal models would provide information in areas where measurements have not been developed for use in humans or would carry a significant hazard if utilized in man.

2. As an important (human element of a flight system whose total performance capability is reflected in the performance level of that (human) system, and whose safety is of primary concern in any manned system:

To acquire, analyze, and interject data relevant to the problems of human performance, capability and behavior in space. This includes both group and individual behavior, attitudes, motivational levels, anxieties, etc.

To establish operator capabilities and requirements as they impact total system performance and crew safety.

To collect high fidelity, high quality data on the new population of space flight participants in order to substantiate and improve on the original medical selection criteria for Shuttle passengers and crews.

B. Although animals, as biological species, will be used as models for manrelated studies, the term Space Biology encompasses research on a wide variety of biological materials ranging from cells to complex multi-cellular animals. Major objectives of the Space Biology program are: To advance our knowledge of the role of gravity in the life processes and the capability of terrestrial organisms to adapt to gravitational changes.

To understand the basic nature of biological rhythms in terrestrial organisms and their influence on life processes.

To determine and assess the biological implications of galactic cosmic HZE particles for developing realistic radiation exposure guidelines and providing protective and/or preventive measures against particle radiation hazards for long duration space missions.

To determine the potential applications and to develop the techniques to utilize new advances in biological theories and space technology gained from research in the unique environment of space for space exploration and for the benefit of mankind. This includes cross-utilization of information between scientific disciplines, especially by means of flight experiments of mutual interest and/or applicability to different disciplines.

To assess the possible synergistic effects of gravity, magnetism and radiation on life-s origin and evolutionary processes.

C. Advanced technology research goals and objectives to be accomplished include but are not limited to:

Continuing advanced technology research on life support, protective systems, and work aids to provide as near an Earth atmospheric environment for man as possible; to provide him with protection from hazards of the space environment, optimize his ability to work in space and to maintain his health. Special emphasis will be placed on areas such as:

Development of regenerative life support systems including bioregenerative systems and new principles of membrane transport and related phenomena, development of advanced protective devices for manned space flight.

Measurement of man's performance in EVA, evaluation and validation of principles of system design and man-machine integration.

Demonstration and flight evaluation of teleoperator technology; e.g., visual environment sensors and displays, man-machine capabilities and acquisition of an experience and engineering data base.

RESEARCH CAPABILITY SYNOPSIS - Area/Functions/Measurements/Major Equipment

A. BIOMEDICAL - Man

1. Vestibular

Investigate role of visual cues in space nausea. Repeat of Skylab M131 experiment. Rotating Litter Chair.

Role of altered body fluid volume, pressure and distribution to space nausea. Urine sample collection and analysis.

2. Cardiovascular

Altered vascular flow, volume and pressure relationships in zero-g. LBNP. VCG.

Demonstrate presence or absence of Gauer-Henry reflex. Early mission urine/blood sample collection and analysis. APE, Freezers.

Regulator responses to exercise in zero-g. VCG, Human Phys. Kit, Exercise Eqmt.

3. Pulmonary

Altered pulmonary volume/flow/relationships in zero-g. Cardiopulmonary Analyzer, Exercise Eqmt.

4. Musculoskeletal

Exercise effect upon musculoskeletal derangement. Exercise physiology equipment, human physiology kit, ECG/VCG.

Diet and pharmacological control of musculoskeletal derangement.

Food/fluid input records, feces/urine/vomitus collection/storage.

5. Hematology

Collect, prepare and preserve blood samples. Determine red cell mass, reticulocyte counts, pCO_9 , pO_9 , pH, enzymes, proteins, etc.

6. Microbiology

Effects of space environment upon host defense mechanisms. Microbial sampling, culturing, staining, examination. Incubator, staining system, microscopy.

7. Crew Performance in Space

Time and motion studies, training tasks. Time-relate performance measures with daily activity schedules, sleep patterns, environmental conditions and biomedical measurements.

8. Effects of Training Upon Crew Efficiency

Correlate arew performance efficiency measurements with same tasks conducted in ground based simulators or prior missions.

B. BIOMEDICAL - Man-Surrogate

To permit detailed invasive and statistical studies in the biomedical areas mentioned above. This laboratory contains the holding facilities, support equipment and monitoring instrumentation for the following populations:

Primates - 2 Holding units (1 primate each)

Small vertebrates - 2 Holding units (16 rats, hamsters, etc.)

Cells/Tissues - 2 Holding units

C. SPACE BIOLOGY

The holding units mentioned in "B" above, besides supporting man-surrogate research, will support space biology research. Additional holding units are:

Plants - 2 Holding units Invertebrates - 2 Holding units

1. Cellular & Molecular Biology

Density dependent growth/development processes. Wound repair rates, membrain electrolyte transport.

Generic alterations in zero-g. Cell metosis, chromosome aberrations, cell divisions.

2. Lower Vertebrate Biology

Basic mechanisms of physiclogical adaptation, growth, development and reproduction in zero-g. Circadian rhythm studies. Metabolic monitoring, physiological monitoring, histological preparations, surgery, environmental monitoring.

3. Higher Vertebrate Biology

invasive studies of the physiological systems as described under "A" above.

4. Invertebrate Biology

Basic mechanisms of physiological adaptation, growth, development & reproduction in zero-g. Complete life cycle studies. Monitor behavior patterns, activity cycles, growth rates, morphology. Histological preparations.

5. Plant Biology

Study basic mechanisms of growth, development and reproduction in zero-g. Geotropism, morphology, photosynthetic activity, productivity.

6. Radiobiology

Biological effects of HZE particle irradiation. HZE particle detection. Exposure of small animals, plants, tissue cultures to HZE radiation.

7. Bioresearch Centrifuge

A 3.88 m diameter centrifuge permits 1-g control organisms on-board to compare with zero-g test organism. Capability of 16 small animal holding units.

D. ADVANCED TECHNOLOGY

1. Life Support Hardware Testing in Zero G

Test condensers, vapor cycle units, sterilizers, $\rm CO_2$ reduction units, biopacks, pressure suits. Life Support Test Console.

2. Effects of Space Inertial Forces on Gravity Sensitive Processes

Examine mixed phased flows, mixing, heat transfer characteristics. Use PI developed hardware test apparatus.

3. Man-Machine Testing of Advanced Designs

Measure man's performance in EVA, systems design, etc. Use psychomotor performance console, Spacelab CRT/keyboard, etc. Evaluate Teleopera tor technology.

E. SUPPORTIVE SERVICES

- Microscopy Compound microscope for dark field, brightfield, phase contrast.

 Dissecting microscope. Microscope accessory kit includes polarizing equipment, filters, photographic and video attachments.
- Photography Cine film, 35 mm, polaroid.
- Visual Records Strip chart recorder (2-channel), digital display oscilloscope, CRT/camera.
- Preservation Cryogenic freezer (quick-freezer), -70° & -20°C freezers, 4°C refrigerator.
- Mass Measurement Human mass device, macro mass measurement device (5 g to 2 kg) and micro mass measurement device (1 mg to 5 g).

PAYLOAD NO. MOD IIIA

EÏ	Name	Q	Unit Wt. kg	Unit Pwr. w	Unit Vol.
	TLUETECONESED	5	0.1	Ō	70.0
1 4	MODELERGHETER CONFLER	6	0.05	1	C-31
•	Tis evelific comfile	1	2.7	ទដ្	0-45
- 54	ATPENEN ROAK SHAFA (F	1	5	75	h
	AUTO ANALYZER (GENGASC)	1	<u> 26</u> _	5 00	48
	AUTO FOTENTION FLECK ANAL.	į	12.7	70 C	57
11	ANALYZEP, GENL. SPECTROPHCT.	:	36	245	9.0
	AVESTHETIZEP, INVERT.		6.5	Ö	1
	MITTHIAS ASSISTED	1	0-1	D	6.01
15	ANTHOSE SAMPLING SYSTEM	1	1.8	3	2.3
	AUDIO STEPEO HEADSET		10	20	25
	AUDIOMETER	1	0.7 5. =	0 2 E	5.7
	BARGES, PARIATION	Ė	4.5 0.2	25	6.4
	ALLISTOCAPTICGPAN COUPLES		0.2	0 ,	0-1
_	CUSTOM DITE BOARNS	•	0.1 0.23	1 7	
	PORY MASS MEAS. DEVICE	÷	36.5	15	0.03 675
pr	CASE, INVESTERSATES	43	0.3	0	0.2
	COLONY CHAMBER, SEALABLE	25	0.2	, 3	C-1
	DAGE, METABULTS, CVT	1	0.8	Š	0.9
	CARE, METABOLIO, PLANT	•	7.	3 C	74.6
S#	CASE, METABOLIO, RATS	i	ė.	20	28.3
29	CASE, PLANT	5	4.5	Ö	56.6
	CASE, PAT, HOMSTED, STANDARD	15	2.3	š	11
	CALCULATOR, POSKET	1	E-67	Ď	Ĉ. 4
7.2	CALERA, CINE	. 1	5	13	5
	CS 1ERA CONTROLLER	ī	13.6	190	28.3
37	CAMETA, FOLAPUIN	1	3.3	ā	5.5
36	CAMERA, TS MM AND STROBE	Ť	5	ā	2
77	CAMERA, VIDEO, RAM	*	4 . 4	15	3
78	CAMERA, VINCO, COLDO	1	7.7	59	6.2
3 8 8	CHAEGA MOUNTS	1	3	จ	3
£60	STALST LIARS AIGO	1	4	10	3
76F	CAPRICHULACHARY AGALYZEP	1	90.7	200	172
	OF ITPIFUES, BLD SHEL FROCESSOR	1	12.7	100	25
433	CENTRIFUGE, BIORESEARCH	1	250	354	6330
44	CHEMICAL C	.2	0.5	0	1.2
444	CHEMICALS, RADIOISCT. TRACERS		0.3	3	0.5
45	CHEMICAL STORAGE CABINET	3	4.7	0	14-1
42	CLEVNED AVCOUNT	1	2.3	106	' 10
50	CLIHOSTAT (FOR FLANTS)	1	3	10	20
	TLINOSTAT (FCP C/T)	1	2	13	4
	COMPACTOR, SOLIDS	1	15	100	113
	LOALBOT COMACTE * EXCESTABILES	1	27.7		113.7
	COOLANT LOOP, LIGUID	1	30	50	25
	COUNTER, COLONY, MANUAL	1	1.5	50	1.5
	DISPLAY KEYROAPH, PORTABLE	1	13.6	50	42.5
	JISHTAA MUMBAIC	₹	2	5	4 _
	FOS COURL SP	24	2-2	2	3.5
	FFG COUPLER	8	ů• 2	S	0.5
	FLECTECHAS. RACKEACK	1	0.3	0	0.28
-	TLECTROPHYS. RECEIVED	1	2.7	25	5.0
-	THE COUPLES	10	0.5	2	ŭ. 5
	TERCTOMETER	1	3.7	3	7.1
	FLFCTPCFPORFRIS APPARATUS	1	9.1	8 F	25.5
	FOUTPHENT RESTRAINT DEVICE	1	0.5.	0	1
	EXERCISE EQUIP., PHYSIDE.	. 1	96	1 3	892
	FILM, CINE	12	0.54	J	0.54
	FILM, FOLAPSIN	15	0.16	9	0.13
(m	FTLM, 35 MM	3:	0.13	3	0.02

PAYLOAD NO. MOD IIIA

EI	Name	Q	Unit Wt. kg	Unit Pwr. W	Unit Vol.
	TETHMETERS (GLOCY CLOT)	6 1	3+5 4+5	1 40	Ç.5 19•å
7+.L	LOLLSED LOAGGENIG	2	21.5	10	74.1
# f5		3	15	20°C	61.4
6.1	cocsine LOW ache	2	8	ic	33.5
	cole (6tenttention)	,	18	50	123
e 7	SAR ANALYTER, INFRAPED	1	11.3	5 ņ	42.6
51	GAS AMALYZES, MASS SPEC.	2	25	5 C	. 20
	GAS ANALYZES, PH	1	5.2	5.	13
	SAS SHEPLIES	6	5.75	0	1.8
66	GLOVE ROX, POSTABLE	. 1	4.5	0	25
	SLOVE BOY LINES	50 .	9.5	3 .	1
	HANDWIFES, BETADYNE	53	0.3	0	6+3
_	HOLDING UNIT, CELLSYTISSUES	5 5	23 23	30 50	138
101	HOLD. UNIT, INVERTESPATES HOLDING UNIT, PLANT	. 2	25	500	186 188
	HOLDING UTT, HONKEY POT	i	53	130	425
	HOLDING UNIT. PPINATE	i	113	130	349
103		÷	13.6	0	188
	THOMBATOR	? 1	5	5	8
165	YTT, CHEMICAL	2	1.5	3	5
105	KIT, HEMATULOSY AND URBLOGY	3	5	D	9
1054	KIT, CLEANUP	3	1.5	3	4
108	VIT, HISTOLOGY	3	1	0	1 .
102		1	1	0	1
111		3	2	0	3
	KIT + HUMAN SHAZICFORA	1	3	Q	ē
111	KIT, PLANT MANAGEMENT	2	1	9	1
	KIT, INVERT. MANAGEMENT	1	1	Ų	2
	VIT, PISSECTION	1	1	0	2 6
	.KIT, VERTERRATE MANAGEMENT KIT, VERTERRATE PHYSIOLOGY	1 1	3 3	9 13	6
	LAME. POPTABLE HI INT. PHOTO	1	6.3	15D	ę s
	LIBUIT STOP. AND DISPENS. SYS.	•	13	ָ ⁵	1.5
	LSS TEST CONSOLE	ĩ	15	ŏ	ร้อง
115		13	C.5	õ	0.4
	LOWER BORY NEG. PRESS. DEVICE	1	78.7	26	2373
118	LYOFHILI750	ī	23	3 00	143
1197	MANIFOLD, VACIPUM	1	9-1	9	28.3
119	MSI TASK SIMILATOP	1	22.7	5	. 200
121	MASS MEAS. DEVICE, MACED	1	11.8	15	32.5
122	The state of the s	1	12	15	25
1231	MASS, TEST, VAPIABLE SIZE	1	9	0	0
	ACUITY ESEPTACE	4	C-45	3_	€.5
	"TOPOSCOME, COMPOUND	1	11	15	27.4
	MICROSCOPE, DISSECTING	1	9	1 `C	28
	MORILITY UNIT, PROTE CORRIDOR	1	22.7 10	0 15	56•6 25
	MOTORIZED PLANT SPONTH HONITOR		0.5	5	Ç.5
	TOTAL TERM STORY AND THE TOTAL STORY OF THE TOTAL S		4.1	อ์	2.8
	OFTISCAN - FIFLD AND FIXED	î	2-3	5	8.5
	CRETLLOSCOPE AND CAMERA	ī	11.7	75	26.9
	STOLITH TEST GOGGLES	ī	0.2	0	2.8
	PAPEO, PECCONING	3	0.5	Õ	1.2
139	PH METER	1	1.5	20	5.2
1765	PHOTOGELL COMFLER	12	0.2	2	9.5
1.39=	PHYSIGE. MULTICHAN. SENS SYS.	. 1	9.2	0	1.4
	PLETHYSMCSRAPH, LIMB	1	2.14	5	6
	PHONOVIERACAPOTOGRAM COUPLED	4	C • S	1	0.3
	PLUMSING	1	20	2	15
147	PORTABLE LSS	1	30.4	0	79

PAYLOAD NO. MOD IIIA			Unit Wt.	Unit Pwr.	Unit Vol.
ΕÏ	Name	Q	kg	W	dm ³
1476	DOUBLER COUPLER	4	C+2	S	6.5
144	ESYCHOROTOP PEPFORM. CONSOLF	1	o • 2	15	13.3
	PTYCHOGAL JANONETER, GSP	1	0.5	1	5 - 3
1 440	PANIATION DETECTOR, DOSTM.	1	0.3	3	0.5
147	PARTION COUNTER	1	15	.5 ₹	5.0
1496	PAD. SOUPCE, SHIFLDED	1	65	5	28.3
1504	SECOONES STOLD CHAST	1	11.8	6	16.9
1500	PECCIVER, BIOTELEHETEY	1	0.5	1 C	1
	PTGORDER, VOICE	1	1	9	1
	PUTATING LITTER CHAIR/DONSOLE	1	155.2	1 27	233
1577	STUSOPS, ASSOPTED	1	C•5	9	0.3
156	SISHAL CONTITIONERS (COUPLERS)	24	0.2	2	0.5
156F	_ 2040Ctbuloeaw	1	19	32	59
15.7	SOUND LEVEL METER	1	. 13.6	0	33.4
1500	SPACESUIT TEST CONSOLE	1	35	50	50
159	STAINING SYSTEM	3	2.2	0	3.5
15?	STERILIZER, AUTOCLAVE	1	11	300	34.7
	STEDILIZES, TOOL	1	1	116	1
	SPACESUIT	1	35.3	1	198.2
174	TANK, VERTEBRATE WATER	3	8.5	5	28.3
	TANK, PLANTATHYFOT, WATER	5	1.7	3	3
1764	r tiskácien, forneztokouf	1	22.7	5	56.6
	THERMOCOUPLE INSTOATOR	1	6	5	9.4
170	AEMBERTANDE BEOUK	1	4.5	200	1.7
	1 THEO 400000EEE	2	0.5	9	0.3
	THERMOMETER, ELECTRONIC	1	5.4	14	8.7
150	TIMED, EVENT	2	5.2	a	0.2
	TRANSOUCER, APESSURE	4	0 + 2	1	0-4
	VCG CONFLED	1	G-2	2	0.5
_	VISION TESTER	1	22.7	100	113.3
	VENTILATION UNIT, VERT.	7	19	4 C	32.7
185	•	1	2	0 .	2.4
1 4 4		1	135	1000	420

DEDICATED LABORATORY MOD IIB SCIENCE RATIONALE & RESEARCH CAPABILITY

SCIENCE RATIONALE

Dedicated Lab MOD IIB is a 7-day space biology emphasis mission for Shuttle/Spacelab. Research will be performed to advance our knowledge of the role of gravity, magnetism and radiation in the life processes of a wide variety of biological material ranging from cells to multicellular animals.

Major objectives of the research are:

To advance our knowledge of the role of gravity in the life processes and the capability of terrestrial organisms to adapt to gravitational changes.

To understand the basic nature of biological rhythms in terrestrial organisms and their influence on life processes.

To determine and assess the biological implications of galactic cosmic HZE particles for developing realistic radiation exposure guidelines and providing protective and/or preventive measures against particle radiation hazards for long duration space missions.

To determine the potential applications and to develop the techniques to utilize new advances in biological theories and space technology gained from research in the unique environment of space for space exploration and for the benefit of mankind. This includes cross-utilization of information between scientific disciplines, especially by means of flight experiments of mutual interest and/or applicability to different disciplines.

To assess the possible synergistic effects of gravity, magnetism and radiation on life's origin and evolutionary processes.

RESEARCH CAPABILITY SYNOPSIS - Area/Functions/Measurements/Major Equipment

A. SPACE BIOLOGY

To permit detailed invasive and statistical studies in the various biological areas of interest, this laboratory contains the holding facilities support equipment and monitoring instrumentation for the following populations:

Primates - 2 Holding units (1 primate each)

Small Vertebrates - 2 Holding units (16 rats, hamsters, fowl, etc.)

Plants - 2 Holding units

Invertebrates - 2 Holding units Cells/Tissues - 2 Holding units

1. Cellular & Molecular Biology

Density dependent growth/development processes. Wound repair rates, membrane electrolyte transport.

Genetic alterations in zero-g. Cell mutosis, chromosome aberrations, cell divisions.

2. Lower Vertebrate Biology

Basic mechanisms of physiological adaptation, growth, development and reproduction in zero-g. Circadian rhythm studies. Metabolic monitoring, physiological monitoring, histological preparations, surgery, environmental monitoring.

3. Higher Vertebrate Biology

Invasive studies in altered vascular flow volume and pressure relationships, absence or presence of myocardial degeneration, absolute catabolic effects of zero-g on musculoskeletal system, mechanical and neural responses of the vestibular system to space environment stimuli and hematological collect, preservation and analysis. Use of work and surgery bench.

4. Invertebrate Biology

Basic mechanisms of physiological adaptation, growth, development and reproduction in zero-g. Complete life cycle studies. Monitor behavior patterns, activity cycles, growth rates, morphology. Histological preparations.

5. Plant Biology

Study basic mechanisms or growth, development and reproduction in zero-g. Geotropism, morphology, photosynthetic activity, productivity.

6. Radiobiology

Biological effects of HZE particle irradiation. HZE particle detection. Exposure of small animals, plants, tissue cultures to HZE radiation.

B. <u>SUPPORTIVE SERVICES</u>

Microscopy - Compound microscope for dark field, bright field, phase contrast.

Dissecting microscope. Microscope accessory kit includes polarizing equipment, filters, photographic and video attachments.

Photography - Cine film, 35 mm, polaroid.

Visual Records - Strip chart recorder (2-channel), digital display oscilloscope, CRT/camera.

Preservation - Cryogenic freezer (quick-freezer), -70° & -20°C freezers, 4°C refrigerator.

Mass Measurement - Macro mass measurement device (5 g to 2 kg) and micro mass measurement device (1 mg to 5 g).

PAYLOAD NO. MOD IIB

EI		Name	Q	Unit Wt.	Unit Pwr. w	Unit Vol.
-	1	ACCELERUMETER		C-1	0	0.33
		TOURTED PARTES SOMETER	7	0.05	i	0.31
	ή		1	2.7	50	0.65
		בישבונה אטמע מוושבינב	i	5	75	6
	7	AHTCAHALYTER (GEMSAFE)	ī	26	305	ŭ C
		ANTO FUTFATTO. FLFC. ANAL.	ī	12.7	100	57
	16	ANTSTHETIZER, INVERT.	1	1.2	3 -	1
	_	ANTENNAS, ARROPTED	1.	€ 4 🕏	ž	6.03
	-	ATMOS. SAMPLING SYSTEM .	Ĭ	13	28	3.5
	_	BARGES, RAPTATTON	Ž	0.≥	0	6-1
		CASE, TILVEDTE PRATES	63	9.3	Ō	C. ?
•		COLONY CHAMSER, SEALABLE	20	0.2	0	E-1
		CAGE, METABOLIC, PLANT	2	7	38	74.6
		CAGE, METABOLIC, PATS	1	8	50	28.3
	29	CAGE, PLANT	2	4.5	9	56.5
	TOA	CAGE, RAT, HAMSTER, STANDARD	16	2.3	9	11
	31	CALCULATOR, POCKET	1	2-47	3	0.4
	72	CLIFFE, CINF	1	5	13	5
	3.57	CAMERA CONTROLLER	1	13.6	100	28.3
	37	CAMPOA, FOLAPOID	1	7.3	3	5.6
		CAMERA, 35 MM AND STROBE	1	2	0	2
	37	CAMERA, VIRTO, R/W	2	4 - 4	15	3
	3.5	GIMERA, VIDEO, GOLOR	1	7.7	59	6 • 5
		CAMERA MOUNTS .	1	3	3	3
100		CAMERA TIMER, VIDEO	1	4	10	3
	464	CENTRIFUGE, BLA SMPL PROCESSOR	1	12.7	100	25
	L L		1	8.5	9	1.0
		CHEMICALS, PARTOTSOT. TRACERS	1	0.3	9	0.5
		CHEMICAL STORAGE CABINET	1	4-0	ָם <u>.</u>	14-1
		OLFANTR, VACHUM	1	2.3	106	10
		CLINUSTAT (FOP PLANTS)	1	3	17	20
		CLINOSTAT (FOP C/T)	1	2	10	<u> </u>
		COOLANT LOOP, LIMUIN	1	30	53	25_
		COUNTER, COLONY, MANUAL	1	1.5	50	1.5
	_	DISPLAY KEYROARD, POPTABLE	1	13.5	50	42.5
		PISPLAY, NUMEPIC	5	2	2	•
		TOS COUPLED	12	0+2	S	8.5
		RES COUPLER	4	0.2	2	0.5
•		ENS COUPLED	5	Č-5	2	2.5
_		FOUTPHENT PESTOAINT DEVICE	1	C.5	0	1
		EXERCISE FOUIP., PHYSIOL.	1	96	18	592
		ETLH, CINE	4	[.54	3	C-54
		FILM, POLAROTO	5	C-15	9	0.13
		FTLM, 25 MM	13	0-13	0	C+35
		FLOHMETERS	4	0.5	1	0.5
		ESEENE, CRYOGENIC	1	21.6	10 200	74-1
		FREZEO, GENERAL	1	15	200 18	61.4
	eı	TUTE ZED, LOW TEMP.	1	8		30.5
		soig. (AFFRIGFPATOR)	1	18	5 G 5 D	120 2J
		SAS ANALYZER, MASS SEEC.	2	25 5•2	· -	13
		GAS ANALYZEP, RH	6	5.75	5 0	18
	•	GAS SUPPLIES			0	25
		GLOVE BOX, POPTABLE	1 22	4.5 6.5	ט פ	1
	960	GLOVE BOX LINESS	23	G.5	G	0.3
		HANDWIFTS, BETADYNE	21	[• 3 23	30	158
		HOLDING UNIT, PELLSTISSUES	?	23	50 50	138
		HOLD. UNIT, INVESTEBRATES	5.	23	50 C	183
		HOLDING UNIT, PLANT	5 4	25 113	100	343
		HOLDING UNIT, PRIMATE HOLDING UNIT, SM. VERT.	5	13.5	9	135
. 1	L . ~	DAMATINA CHATAN DUN AMASA	6	7360	7	109

PA	YLOAD	NO.	MOD	IIB

EI	Name	Q	Unit Wt.	Unit Pwr. w	Unit Vol. dm ³
1,6 40	THOMPATOR	1	5	5	8
169	KIT, THEMICAL	1	1.5	0	5
105		1	5	0	9
-	KIY, CLEANIP	1	1.5	0	4
	MIT, HISTOLOGY	1	1	Ü	1
	KIP, LINFAP MFAS.	. 1	1	0	1
	MIT, HICPORIOLOGY	1	2	0	3
	KIT, FLANT MANAGEMENT	1	1	0	1
	MIT, INVERT. MANAGEMENT	1	1	3	2 2
	KIT, DISSECTION KIT, VERTERRATE MANAGEMENT	1	. 1	0	Z
	*	1 1	3	9	6
	KIT, VERTEBRATE PHYSICLOGY	1	3	9	6
	LAMP, POPTABLE HI INT. FHOTO LIDUTO STOR. AND DISPENS. SYS.		6.3	150	•
	LOG BOOKS	2 3	13	0	18
	MANIFOLD. VACUUM	1	C.5	9 9	0 - 4
	MASS MEAS. DEVICE, MACRO	i	9-1 11-5	15	28.3 32.8
	MASS MEAS. DEVICE. MICRO	i	12	15	25
	PENIA, PRESAREN	ž	û.45	0	0.5
	MTCPOSCUPE, COMPOUNT	1	11	15	27.4
	MICHURCORE, MIRSTOTING	i	ŝ	1 00	28
	TIOP. ACCESS. KIT. SOMPNS	ī	ío	15	25
	MOTOPIZED PLANT GPOATH MONITOR	ž	0.5	5	E . 6
132		ī	11.7	75	28.9
	PAPER, RECORDING	1	c.6	<u>.</u>	1.2
178	<u> </u>	ī	1.8	žo	5.2
1393	PHOTOCFLL COMPLET	12	0.2	2	0.5
1365	PHYSICL. MULTICHAN. SENS SYS.	1	9-2	3	1.4
1414	PLUMBING	i	26	5	15
	COERCIONE COMPLES	4	0.2	2	G.5
	PATIATION OFFECTOR, POSIM,	1	C • 3	9	€.5
	SECONDES. SESTO CHUSE	1	11.5	3	16.9
	RICETVER, STOTILEMETRY	1	0.5	10	1
153	SECONDER, NOTCE	1	1	0	1
	SENSORS, ASSORTED	1	0.5	0	0 + 3
	SIGNAL CONTITIONEDS (COUPLEDS)	12	9-2	2	€+5
	SOUND LEVEL METER	1	13.6	9	33.4
	STAINING SYSTEM	1	2.2	0	3.5
	STERILIZER, ANTOCLAVE	1	11	300	34.7
	STERTLIZEP, TOOL	. 1	1	115	1 -
174	TANK, VERTERRATE HATER		6.5	5	25.3
	TANK, PLANT/INVERT, WATER THERMOCOUPLE INDICATOR	3	1.7	0	3
	TEMBERATURE STOCK	1	6	3	9.4
	TATEMOCCUPLES	1	4-5	200	1.7
	THERMOMETER: ELECTRONIC	1	C•5 5•4	0 14	G•3 8•7
_	TIMER, EVENT	1 2	0.2	0	0.2
	Tath Zunces sales	4	0.2	1	0 • 2 C • 4
	VOS COUPLEP	1	C+2	5	0.5
	VENTILATION WHIT, VERT.	2	19	40	32.7
	VERTERRATE ECS	ī	38	32G	121
_	PULTIMETER	i	2	õ	2.4
	HORK AND SUPGICAL BENCH	ī	136	1000	420

DEDICATED LABORATORY MOD IIC SCIENCE RATIONALE & RESEARCH CAPABILITY

SCIENCE RATIONALE

r

Dedicated Lab MOD IIC is a 30-day space biology emphasis mission for Shuttle/ Spacelab. Research will be performed to advance our knowledge of the role of gravity, magnetism and radiation in the life processes of a wide variety of biological material ranging from cells to multicellular animals.

Major objectives of the research are:

To advance our knowledge of the role of gravity in the life processes and the capability of terrestrial organisms to adapt to gravitational changes.

To understand the basic nature of biological rhythms in terrestrial organisms and their influence on life processes.

To determine and assess the biological implications of galactic cosmic HZE particles for developing realistic radiation exposure guidelines and providing protective and/or preventive measures against particle radiation hazards for long duration space missions.

To determine the potential applications and to develop the techniques to utilize new advances in biological theories and space technology gained from research in the unique environment of space for space exploration and for the benefit of mankind. This includes cross-utilization of information between scientific disciplines, especially by means of flight experiments of mutual interest and/or applicability to different disciplines.

To assess the possible synergistic effects of gravity, magnetism and radiation on life's origin and evolutionary processes.

RESEARCH CAPABILITY SYNOPSIS - Area/Functions/Measurements/Major Equipment

A. SPACE BIOLOGY

To permit detailed invasive and statistical studies in the various biological areas of interest, this laboratory contains the holding facilities support equipment and monitoring instrumentation for the following populations:

Primates - 2 Holding units (1 primate each)
Small Vertebrates - 2 Holding units (16 rats, hamsters, fowl, etc.)

1. Cellular & Molecular Biology

Density dependent growth/development processes. Wound repair rates, membrane electrolyte transport.

Genetic alterations in zero-g. Cell mutosis, chromosome aberrations, cell divisions.

2. Lower Vertebrate Biology

Basic mechanisms of physiological adaptation, growth, development and reproduction in zero-g. Circadian rhythm studies. Metabolic monitoring, physiological monitoring, histological preparations, surgery, environmental monitoring.

3. Higher Vertebrate Biology

Invasive studies in altered vascular flow volume and pressure relationships, absence or presence of myocardial degeneration, absolute catabolic effects of zero-g on musculoskeletal system, mechanical and neural responses of the vestibular system to space environment stimuli and hematological collect, preservation and analysis.

Use of work and surgery bench.

4. Radiobiology

Biological effects of HZE particle irradiation. HZE particle detection. Exposure of small animals to HZE radiation.

B. SUPPORTIVE SERVICES

Microscopy - Compound microscope for dark field, bright field, phase contrast.

Dissecting microscope. Microscope accessory kit includes polarizing equipment, filters, photographic and video attachments.

Photography - Cine film, 35 mm, polaroid.

Visual Records - Strip chart recorder (2-channel), digital display oscilloscope, CRT/camera.

Preservation - Cryogenic freezer (quick-freezer), -70° & -20°C freezers, 4°C refrigerator.

Mass Measurement - Macro mass measurement device (5 g to 2 kg) and micro mass measurement device (1 mg to 5 g).

PAYLOAD NO. MOD IIC

T. T	, Nome o	•	Unit Wt.	Unit Pwr.	Unit Vol.
EI	Name	ବ	kg	W	dm ³
1	20086850HEZES	*	0.1	3	0.03
-	TOUTHER CHELES DUMBFES	*	0.35	1	C-71
5,		1	2.7	50	0.85
	STREECH HOPE SUPFACE	1	5 ·	75	6
7		1	26	S 20	4 B
	AUTO FOTFHTID. FLFC. ANAL.	1	12.7	10 Ç	57
	ANTENNAS, ASSORTED	1	Ω• 1	9	0.33
	ATMOS. SAMPLING SYSTEM	1	10	20	28
	PANGES, PANTATION	5	0.42	<u>a</u>	0.1
	CASE, PAT, MARKET, STANDARD	15	2.3	9	11
	CAECHEATUR, POCKET	4	8-47	3	D • 4
32			5	13	5
	CAMERA CONTROLLER	1	13.6	100	28.3
37	CAMERA, FOLAROID	1 ? 1	3.3	3	5.6
36	CAMEPA, 35 MM AND STROBE	1	2	. 3	2
	CAMERA, VIDED, S/M	3	4.4	15	3
3.5	CAMERA, VINFO, COLOR	1	7.7	59	5.2
_	CAMEDS MOUNTS		3	3	3
	CAMEDA TIMER. VIDEO	1	4	10	3
4.02	COTATOIRUSE, BLB CHPL PROCESSOR	1	12.7	100	25
44	CHEMICALS	1	3.5	. 3	1.7
424	CHEMICALS, PARTOISOT. TRACERS	1	0.3	9	0.5
	CHEMICAL STOPAGE CABINET	1	4.3	a	14-1
	QLEANER, VACUUM	1	2.3	100	10
51F	' COOLANT LOOP, LIGHIN	1	30	50	25
54	COUNTER, COLONY, MANUAL	1	1.5	5.0	1.5
672	PISPLAY KEYBOAPD, PORTABLE	1	13.6	58	42.5
ት <u>ን</u> ሮ	TISPLAY, NUMERIC	1.	2	2	4
64	FCG COUPLER	1?	0.2	2	8.5
€5	ers constro	ž,	ؕ2	2	0.5
66	THIS COUFLED	6	3.2	2	0.5
700	FOUTPHENT PESTPAINT DEVICE	1	0.5	8	1
7(5	TXERCISE EQUIP., PHYSIOL.	1	96	18	992
	FILM, CINE	12	0.54	5	6.54
	FILM. FCLAPOTO	15	0.15	j	5-13
	FILM, 35 HM	2 9	0.13	0	6.05
	FLOWMETERS	4	0.5	ĭ	0.5
778	FREEZER. CRYDGENIC	1	21.5	10	74.1
6.0	FEEF ZEO, GENFOAL	š	15	200	61.4
51	FOEE ZEP, LOW TEMP.	1	8	10	30.5
83	FRIG. (PEFRIGERATOR)	ž	18	50	120
	GAR ANALYTER, MASS SPEC.	2	25	50	20
	GAS ANALYZER. PH	ī	5.2	6	13
_	GAS SUPPLIES	6	5.75	Ö	18
-	GLOVE BOX, POPTABLE	1	4.5	ā	25
	GLOVE BOX LINERS	20	0.5	Ŏ	1
	HANDWIES, SETABYNE	5.0	0.3	ă	.0.3
	HOUDING UNIT, HONKEY POD	ì	53	100	425
	HOLDING UNIT, PRIMATE	i	113	108	340
	HOLDING UNIT. SM. VERT.	ž	13.6	ů .	188
	KTT. CHEMICAL	5	1.5	õ	5
	KIT, HEMATOLOGY AND UROLOGY	ž	5	· ŭ	ģ
	KIT. CLF4WIP	1	1.5	Ď	4
	KIT, HISTOLOGY	. 2	1		1
	KTT, LINEAP MEAS.	1	1	9	i
	VIT, MICPUBIOLOGY	5	2	Ğ	3
	KIT, DISSECTION	1	1	0	2
4425	KTT, VERTERRATE MANAGEMENT	1		3	<u> </u>
	KIT, VERTERPATE SHYSIOLOGY		3	0	6 .
		1		-	
114,	LAMP, PORTABLE HI INT. PHOTO	1	6.3	15C	6

PAYLOAD NO. MOD IIC

			<u>.</u>	Unit Wt.	Unit Pwr.	Unit Vol.
EI	Name		Q	kg	w	dm ³
1145	LTOUTH S	TOP. ANT DISPENS. SYS.	2	13	3	18
116	1.05 BOOK	5	, E	6.5	Ō	5.4
	Haniesfy		1	9.1	õ	. 28.3
12:	ママンこ いたげ	S. DEITOF, MACRO		11.9	15	32.8
:22	MARS MEA	S. DEVICE, MICRO	1	12	1.5	25
1.56	MICROSCO	PE, COMPOUND	. 1	11	15	27.4
		PF, DISSECTING	1	9	1.00	28
1251	DA «FOIM	CESS. KIT, COMPNO	Ż,	10	15	25
132		COFF AND CAMEPA	1	11.7	75	23.9
1340	ಎಸ್ಎಕಎ, ಇ	FCUPRING	3	£.5	9 -	1.2
135	SH GELED	The Artist Control of the Control	1	1.8	20	5.2
1.763	PHOTOGEL	L COMPLER	12	0.2	2	€.5
1300	PHYSIOL.	MULTICHAN. SENS SYS.	1	C-2	ā	1-4
	PLUMBING		1.	20	2	15
1436	SSE 22110E	COMPLER	4	0.2	. 2	0.5
1440	PADIATIO	N. DETECTOP, MOSIN.	1	0.3	Ō	0.5
1554	っさじりゅうせい	* cials Cnysi	1	11.8	ō	16.9
1509	PECETVER	# STOTTLEMETRY	1	0.5	15	1
153	っこじりょうたら	, VOIGE	· 1	1	ð	1
1573		^A55027E9	. 1	0.5	Ď	9.3
1 m s	TIGHAL C	ONDITIONERS (COUPLERS)	15	C.2	2	0.5
		VEL METED	1	13.5	ā	33.4
159	STAINING	2424m4	2	2.2	Ō	3.5
165	STEPILIZ	FR, TUOL	1	1	110	1
174	TANK, VE	PTERMATE WATER	3 .	8.5	5	29.3
1763		UPLF INDICATOR	1	6	8	9.4
175		USE SLOCK	1	4.5	200	1.7
1794	THERMOCO	ilblied	1	0.5	ã	0.3
		TER, FLECTRONIC	i	5.4	14	8.7
	TTMER, E		2	C+2	n	6.2
		हरे , स्ट्रिड्सिस्ट	Ĩ,	2.2	i	0.4
	VOS COUP		1	5-2	ž	0.5
1822	VENTILAT	ION WHIT, WEST.	2	19	40	32.7
	VERTERRA		ī	38	320	121
185	MULTIMET	E D	· 1	2		2.4
100		SURGICAL BENCH	Ī	136	1 000	429

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

DEDICATED LABORATORY MOD IIIB SCIENCE RATIONALE & RESEARCH CAPABILITY

SCIENCE RATIONALE

Dedicated Lab MOD IIIB is a 30-day space biology emphasis mission for Shuttle/Spacelab. Research will be performed to advance our knowledge of the chronic effects of gravity, magnetism and radiation in the life processes of multicellular animals. A Bioresearch Centrifuge in the laboratory permits 1-g control organisms to be studied along with their zero-g counterparts.

Major objectives of the research are:

To advance our knowledge of the role of gravity in the life processes and the capability of terrestrial organisms to adapt to gravitational changes.

To understand the basic nature of biological rhythms in terrestrial organisms and their influence on life processes.

To determine and assess the biological implications of galactic cosmic HZE particles for developing realistic radiation exposure guidelines and providing protective and/or preventive measures against particle radiation hazards for long duration space missions.

To determine the potential applications and to develop the techniques to utilize new advances in biological theories and space technology gained from research in the unique environment of space for space exploration and for the benefit of mankind. This includes cross-utilization of information between scientific disciplines, especially by means of flight experiments of mutual interest and/or applicability to different disciplines.

To assess the possible synergistic effects of gravity, magnetism and radiation on life's origin and evolutionary processes.

RESEARCH CAPABILITY SYNOPSIS - Area/Functions/Measurements/Major Equipment

A. SPACE BIOLOGY

To permit detailed invasive and statistical studies in the various biological areas of interest, this laboratory contains the holding facilities, support equipment and monitoring instrumentation for the following populations:

Small Vertebrates - 2 holding units (16 rats, hamsters, fowl, etc.) in laboratory; 16 holding stations in Centrifuge.

1. Small Vertebrate Biology

Invasive studies in altered vascular flow volume and pressure relationships, absence or presence of myocardial degeneration, absolute catabolic effects of zero-g on musculoskeletal system, mechanical and neural responses of the vestibular system to space environment stimuli and hematological collect, preservation and analysis.

Basic mechanisms of physiological adaptation, growth, development and reproduction in zero-g. Circadian rhythm studies. Metabolic monitoring, physiological monitoring, histological preparations, surgery, environmental monitoring.

2. Bioresearch Centrifuge

A 3.88 m diameter centrifuge permits 1-g control organisms on-board to compare with zero-g test organisms. Capability of 16 small animal holding units.

B. SUPPORTIVE SERVICES

Microscopy - Compound microscope for dark field, bright field, phase contrast.

Dissecting microscope. Microscope accessory kit includes polarizing equipment, filters, photographic and video attachments.

Photography - Cine film, 35 mm, polaroid.

Visual Records - Strip chart recorder (2-channel), digital display oscilloscope, CRT/camera.

Preservation - Cryogenic freezer (quick-freeze), -70° & -20°C freezers, 4°C refrigerator.

Mass Measurement - Macro mass measurement device (5 g to 2 kg) and micro mass measurement device (1 mg to 5 g).

PAYLOAD NO. MOD HIB

ei	Name	Q	Unit Wt.	Unit Pwr. W	Unit Vola dm ³
1	1COFFED ARABO	5	9.1	9	9.93
1.5	101EFEUTIELES JOHEFES	5	0.05	i	0.01
6		1	2.7	53	0.85
64	ATALFOR MOSK SUBLACE	ĩ	5	75	6
7	ANTO ANALY ZER (SEMPARC)	1	26	206	40
7.5	ANTO POTERTIO. FLEC. ANEL.	í	12.7	100	57
147	ANTENNAS, ASSOPTED	1	C.1	9	0.03
1 5A	ATMOS. SAMPLING SYSTEM	1	10	3.0	2.6
157	PATISES, FAMIATTON	1 5	ű. Z	3	Ğ.1
2 =	GAST, METARCLIT, PATS	1	9	5.0	29.3
PPA	CASE, PAT, MAISTED, STANDARD	15	2.3	9	11
3.1	GALGULATOS, POCKET	1	6.47	9	0.4
32		ĭ	Š	13	5
32A	CAMERA CUNTROLLER	i	13.6	100	26.3
	CAMEDA, FULLAROTH	ī	3.3	1	5.6
36		ī	5	ō	2
77	CAMEDA, VIDEO, RAN	Ş	4.4	15	3
76		ī	7.7	59	6.2
	SAMERA MOUNTS	i	3	9	3
	uration alaba Albab	i	4	10	3
	SENTERFUSE, BLY SHEL PROCESSOR		12.7	ios	
	CENTRIFUGE, ALDRESEARCH	•	250	354	25 5000
44		•	0.5		6800
	CHEMICALS, PADICTSOL TPACEPS	1	3.3	0	1.0
	CHEMICAL STOPAGE CABINET	i		0	C - 5
	CLEANER, VACUIT	1	%•C 2•3	3	14-1
	GOOLANT LOOP, LIDUID	1		100	10
E.F.	GOUNTER, COLONY, MANUAL	i	30	50	25_
670	DISPLAY KEYROAPH, POPTABLE	1	1.5	50	1.5
		1	13.5	50	42.5
	TISPLAY, NUMERIC	1	2	Š	4
	TCS COUPLED	16	3.5	2 2	0.5
	FFG SCHELES	6	0.5	Š	0.5
66		•	0.2	2	0.5
	FRITZHENT SESTRATHY DEVICE	1	0.5	. 0	1
	TYEPOTSE EQUIP., PHYSIOL.	1	96	18	992
	FILH. CINF	12	0.54	8	0.54
	FILM, POLAROTA	15	0.16	0	C-13
	FILM, 35 MM	\$0	0-13	0	0.05
	FLOWMETERS	5	0∙ 5	1	0.5
	FREEZER, CRYOGENIC	2	. 21.5	19	74.1
t t	TREE ZER, GENEPAL		15	200	61.4
£1	EDER ZED, LOW TEMP.	1	· 8	10	30.5
	FRIG. (REFERIGERALTOR)	?	18	50	127
	GAS ANALYZES, MASS SPEC.	5	25	5 O	23
	GAS ANALYTER, PH	1	5.2	5	13
	GAS SUPPLIES	6	5.75	D	18
	GLOVE BOX, PORTABLE	1	4.5	ð	25
	CLOVE BOX LINESS	23	0.5	C	1
	HANDWIFES, METADYNE	23	5-3	0	8.3
113	HOLDING UNIT. SM. VERT.	2	13.6	9	155
	YIT, CHEMTOAL	2	1.5	Ō	5
47 t	KTT, HEMATOLOGY AND UROLOGY	2	5	Ö	9
	KIT, CLEANUP	3	1.5	ā	i,
871	KIT, HISTOLOGY	2	1	ä	i
ī ū a	KIT. LINTAR MEAR.	2	1	Õ	ī
	KIT, MICROSIOLOGY	5	2	Ď	3
	MIT, DISSECTION	1	ĭ	ă	2
1148	KTT, VERTESPATE MANAGEMENT	ī	3	ŏ	6
1140	KIT, VERTERRATE CHYSTOLOGY	i	ž	ŏ	. 6
	LAME, FORTABLE HI INT. FHOTO	i	6.3	150	6

PAYLOAD NO. MOD IIIB

EI	Name	Q	Unit Wt. kg	Unit Pwr. W	Unit Vol. dm ³
1145	LIGUID STOP. AND DISEFUS. SYS.	₹	13	0	13
	LGG 300KS	5	0.4 আ	3	0.4
1181	MANIFOLD, VACUMM	1	9.1	3	25.3
121	MASS MEAS. DEVICEN MACTO	1	11.8	15	32.8
1?2	HASS MEAS. DEVICE, MICRO .	1	12	15	25
126	MICPORCORS, COMPOUND	1	11	15	27.4
1264	MICROSCOFF, DISSECTING	1	. 9	100	25
1261	MICH. ACCESS. KIT, COMPAND	1	10	15	25
123	DISTLLOSCOPE AND CAMERA	1	11.7	7 5	28.9
1767	DADES, BECCOSING	3	0.6	D	1.2
134	BH WEALS	1	1.5	2 7	5.2
1 26 5	FHOTOGELL CONFLET	12	5-2	2	0.5
1385	PHYSIOL. MULTICHAN. SENS SYS.	1	0.2	0	1.4
1414	PLUMBING	1	20	Ş	15
1436	SPESSINE COUPLES	4	0-2	2	0.5
1440	PADIATION DETECTOR, DOSIN.	1	0.3	9	0.5
	PECORNER, STRIP CHART	1	11.5	Ö	16.9
1508	PECEIVER, BIOTELEMETRY	1	0.5	10	1
153	PERORDER, VOICE	1	1	0	1
1573	SENSORS, ASSORTED	1	0.5	0	0.3
156	PIGNAL CONDITIONERS (COUPLERS)	16	0.2	2	0.5
157	SOUND LEVEL METER	. 1	13.6	3	33.4
159	STAINING SYSTEM	2 1	2.2	0	3.5
155	STEPILIZER. TOOL		1	110	1
174	TANK, VERTERRATE WATER	2	e.5	5	28.3
1753	FUEPHOCOMPLE INDICATOR	1	6	5	9.4
179	TEMPERATURE BLOCK	1	4.5	206	1.7
1701	THEPHOCOUPLES	1	8.5	ð	0.3
1757	THERMUMETER, SLECTRONIC	1	5.4	14	ê.7
180	TIMEP, EVENT	2	t-2	0	0.2
1517	TRANSPUCER, PRESSURE	4	5.2	1	0.4
	VCG COUPLER	1	0.2	2	0.5
1029	VERTFARATE FOS	1	38	320	121
185	MULTIMETER	1	2	٥	2.4
168	WORK AND SURGICAL BENCH	í	136	1000	423

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR APPENDIX C
LABORATORY AND BIORESEARCH CENTRIFUGE LAYOUT DRAWINGS

APPENDIX C

LABORATORY AND BIORESEARCH CENTRIFUGE LAYOUT DRAWINGS

This appendix contains the major drawings produced in the study. They are presented in the following order:

Laboratory

Mini-lab ML-1A

Mini-lab ML-2A

Mini-lab ML-3A

Mini-lab ML-4A

Mini-lab ML-5A

Mini-lab ML-2B

Mini-lab ML-2C

Mini-lab ML-2D

Dedicated MOD IA

Dedicated MOD IIA

Dedicated MOD IIIA

Dedicated MOD IIB

Dedicated MOD IIC

Dedicated MOD IIIB

Bioresearch Centrifuge

Accommodation Concept A

Accommodation Concept B

Accommodation Concept C

Accommodation Concept D

Accommodation Concept E

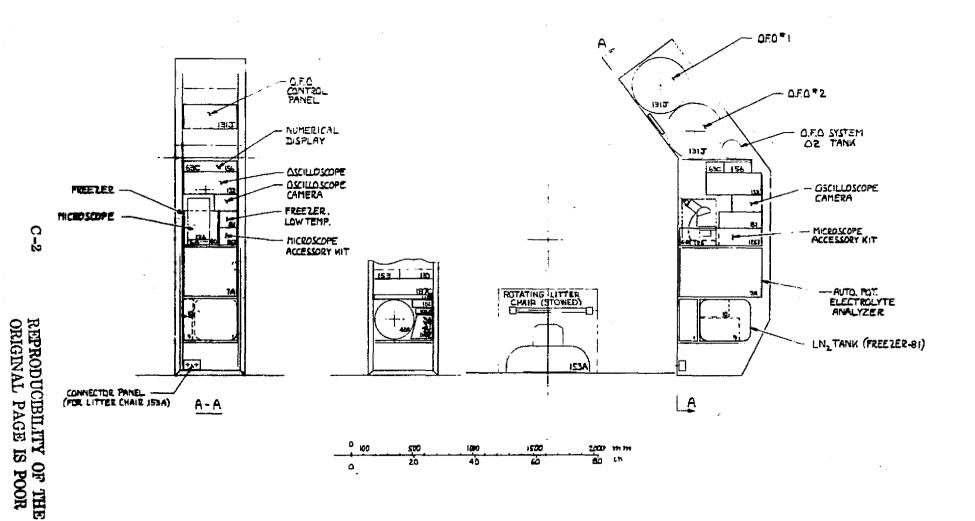
Accommodation Concept F

Detail Design A

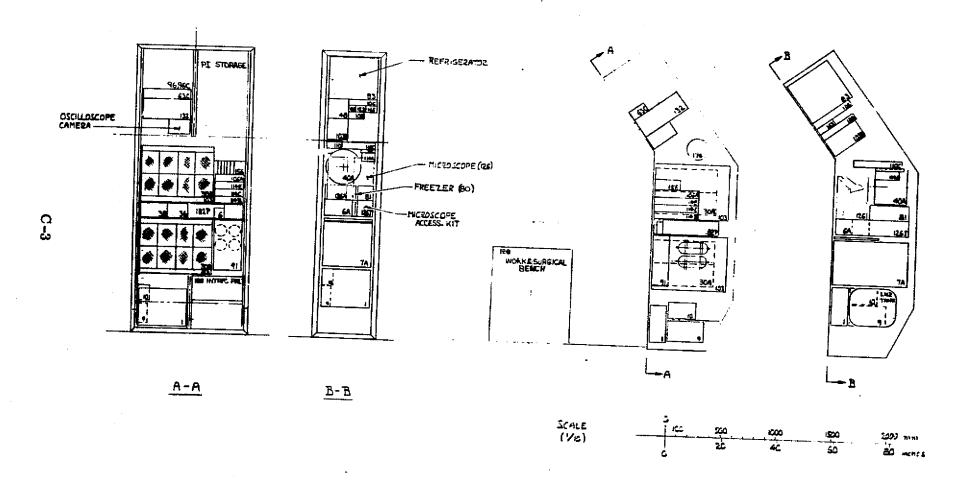
Detail Design B

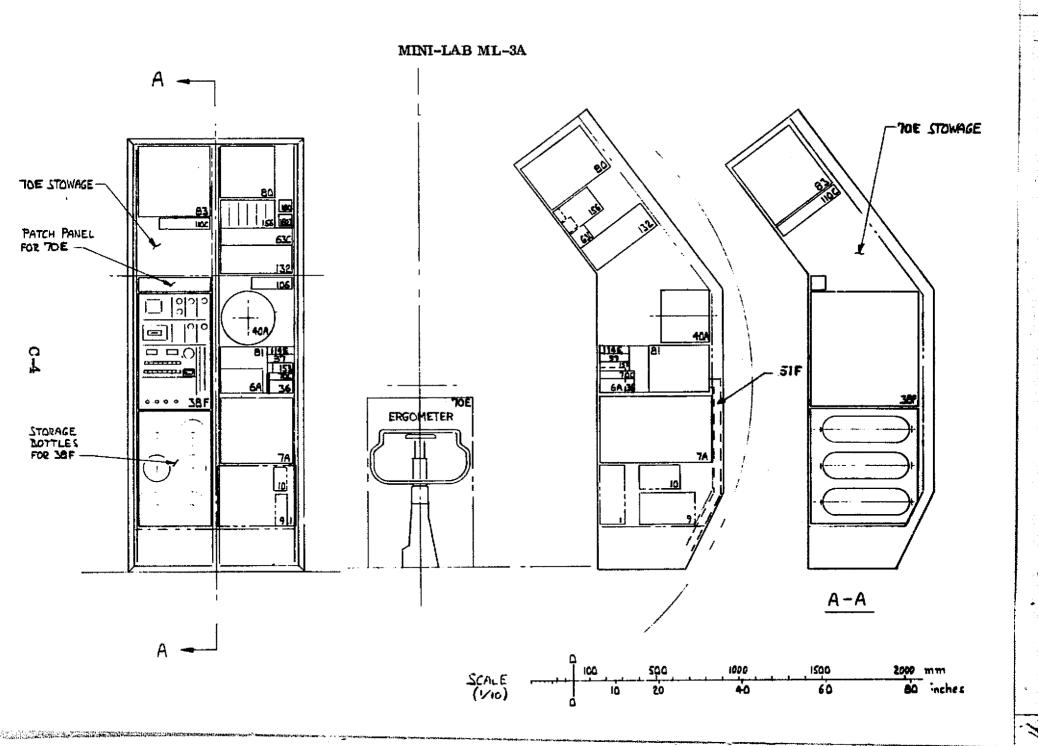
Detail Design D

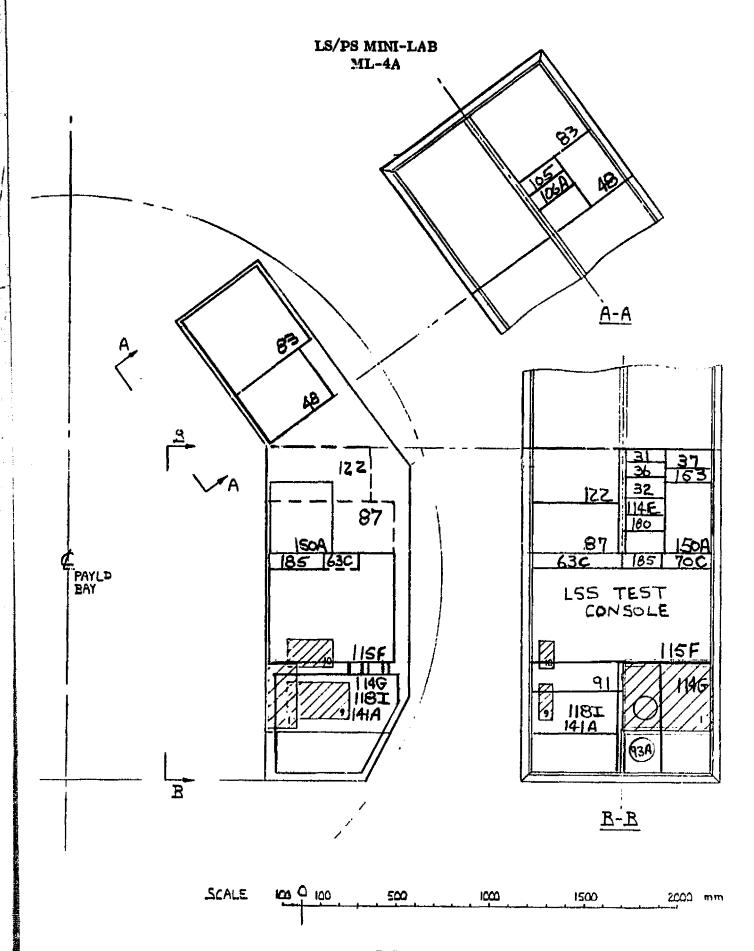
The numbers given in the laboratory drawings refer to the equipment item (EI) number. The identification and characteristics of each EI are found in the respective laboratory equipment listing in Appendix B. The units labeled "1," "9," and "10," however, are Spacelab hardware — electrical power switch panel, dc-converter and remote acquisition unit (RAU), respectively.

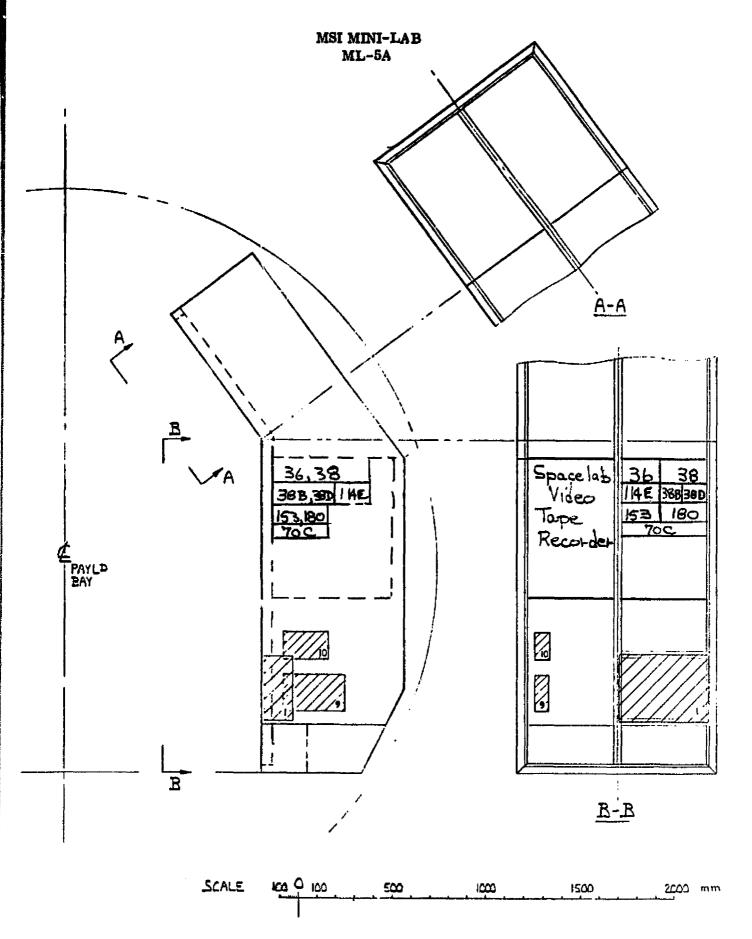


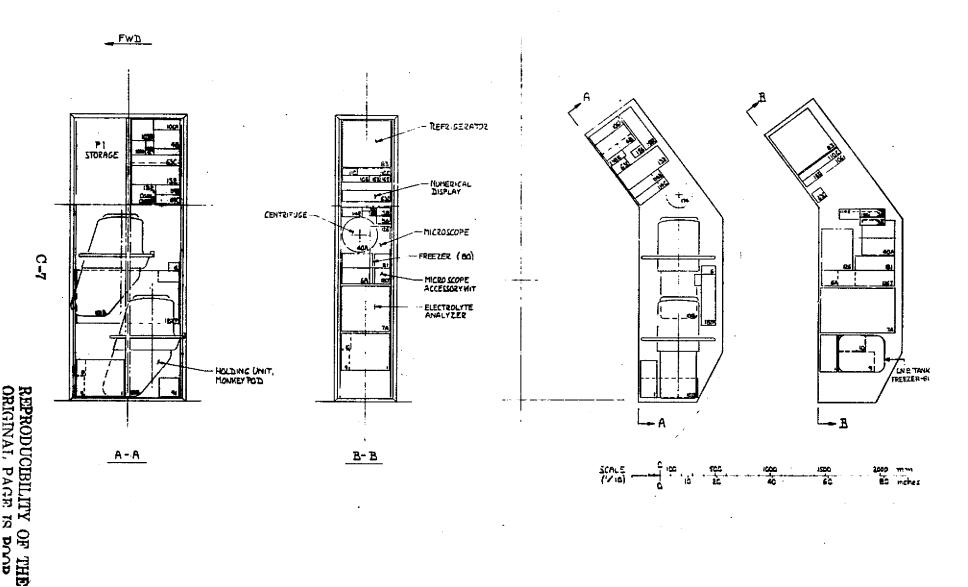
MINI-LAB ML-2A



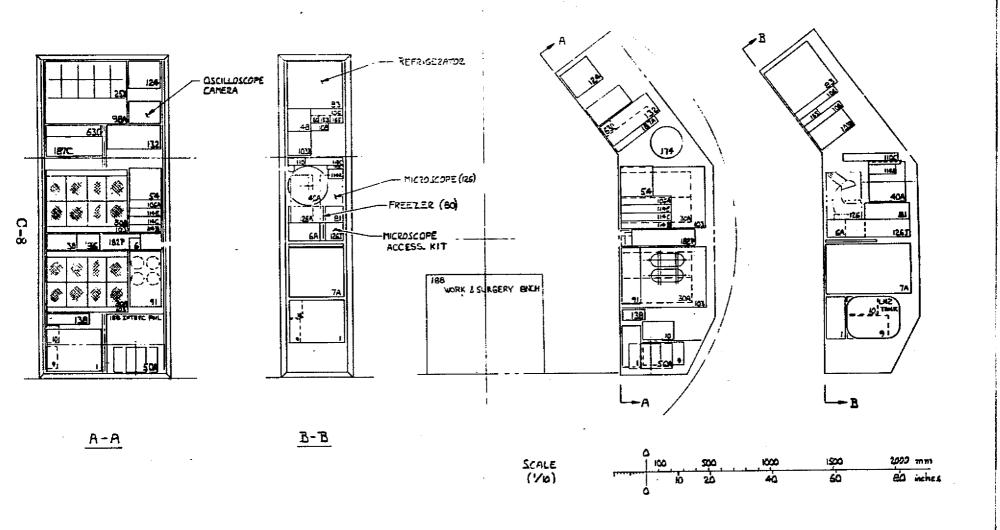




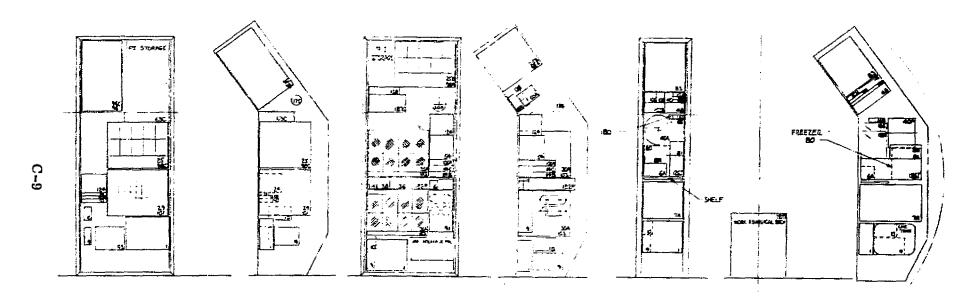




MINI-LAB ML-2C

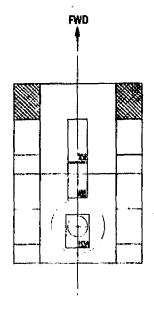


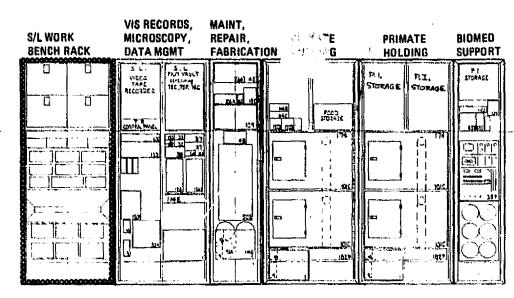
BIOLOGY MINI-LAB ML-2D



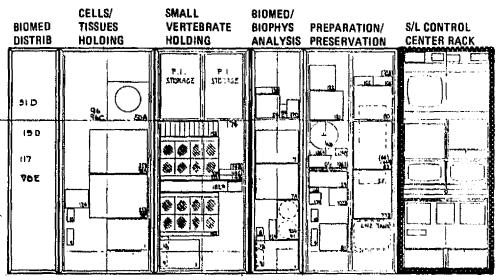
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DEDICATED MOD I A



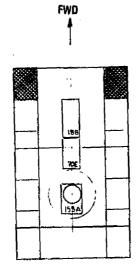


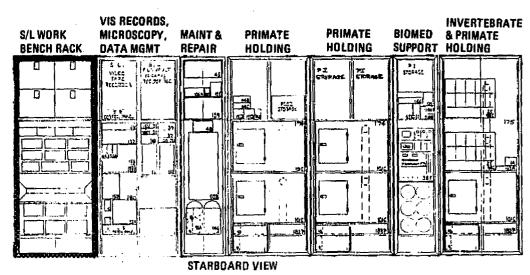
STARBOARD VIEW

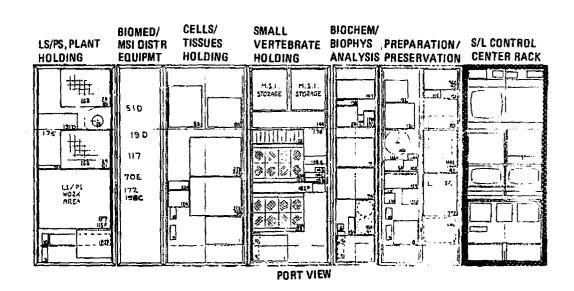


PORT VIEW

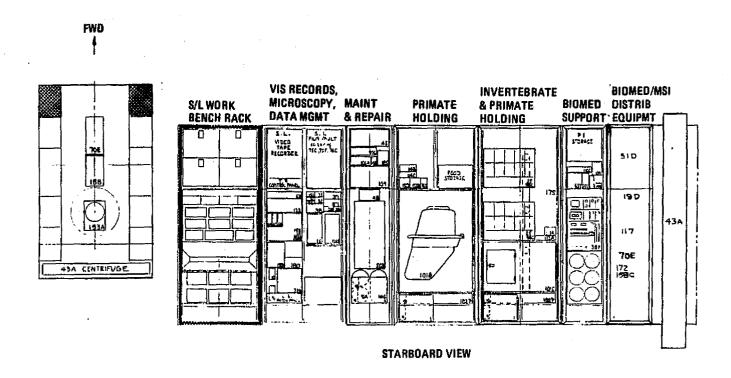
DEDICATED MOD II A

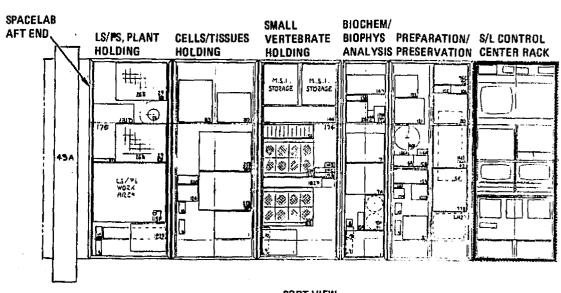






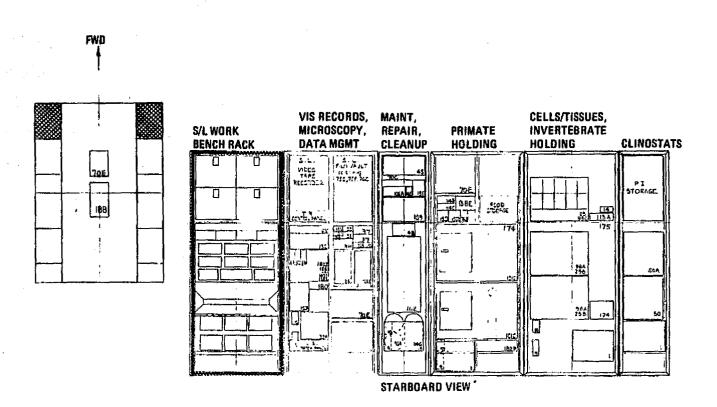
DEDICATED MOD III A

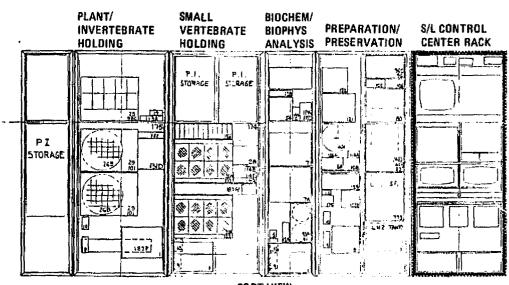




PORT VIEW

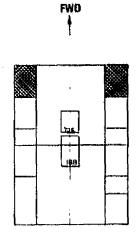
DEDICATED MOD II B

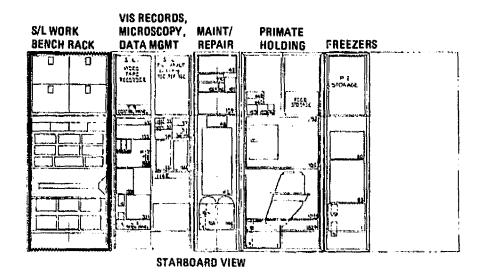


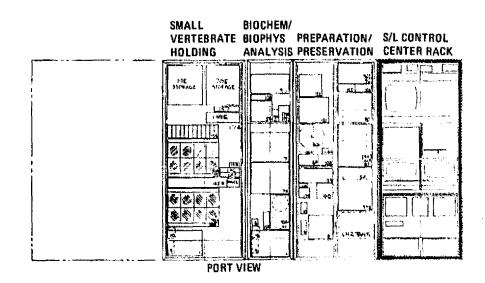


PORT VIEW

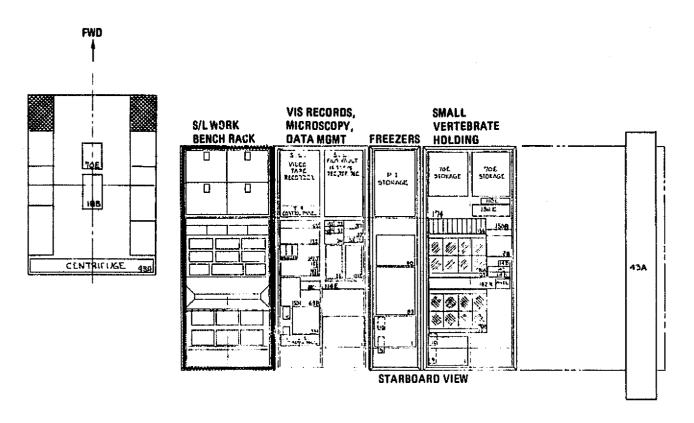
DEDICATED MOD II C

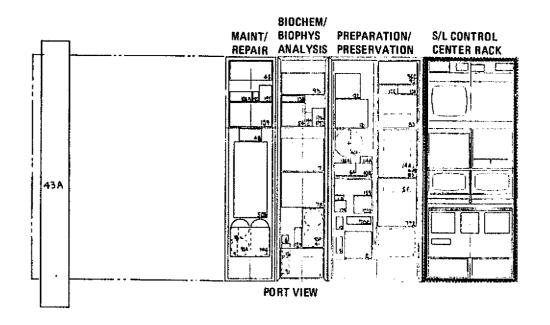




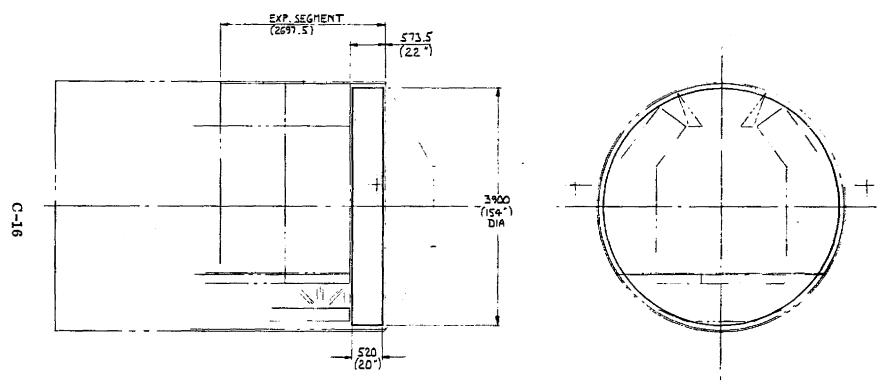


DEDICATED MOD III B

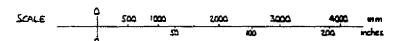




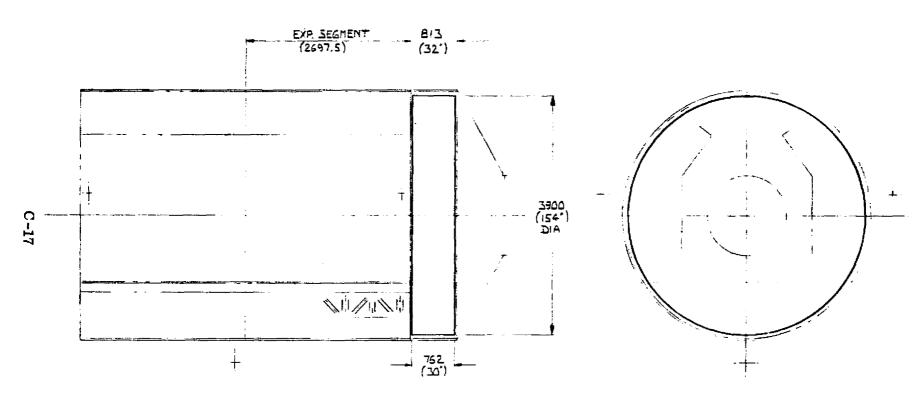
BIORESEARCH CENTRIFUGE ACCOMMODATION CONCEPT A



- 154 CENTRIFUGE ACCOMMODATED WITHIN AFT BAY OF EXISTING EXP. SEGMENT AXIAL LENGTH RESTICTED TO APPROX. 20"
- WITHIN THIS ZO'SECTION ALL RACKS FLOOR BEAMS AND CEILING STRUCT. ARE REMOVED. ALL SYSTEMS ARE RE-ROUTED OR RELOCATED.
- LOSS OF RACK SPACE
 LOSS OF CREW SPACE
 LOSS OF CREW SPACE
 LAB. MODULE MODIFICATION
 S%



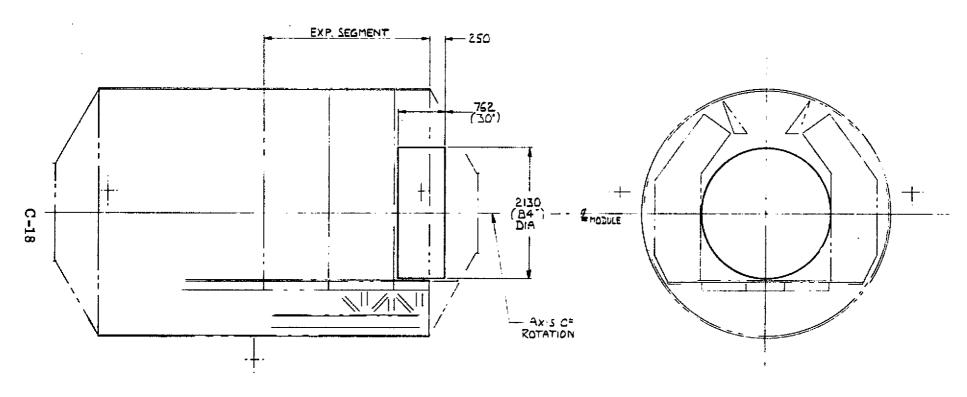
BIORESEARCH CENTRIFUGE ACCOMMODATION CONCEPT B



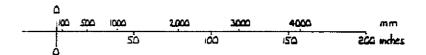
- 154 DIA CENTRIFUGE ACCOMMODATED IN 32 EXTENSION TO EXISTING EXP. SESMENT
- SINGLE PIECE EXTENSION STRUCT, INCORPORATING END CONE, OR CYLINDRICAL EXTENSION STRUCT, PLUS EXISTING END CONE, THE LATTER RESULTING IN AN ADDITIONAL SEALED JOINT.
- . NO IMPACT ON EXISTING EXP. SEGMENT STRUCTURE OR SYSTEMS.
- . NO IMPACT ON EXISTING RACK CAPACITY OR CREW SPACE
- NEW STRUCT, DESIGN TASK
 10 TO 15 %
 NEW STRUCT, FAB. TASK
 5 TO 20 %



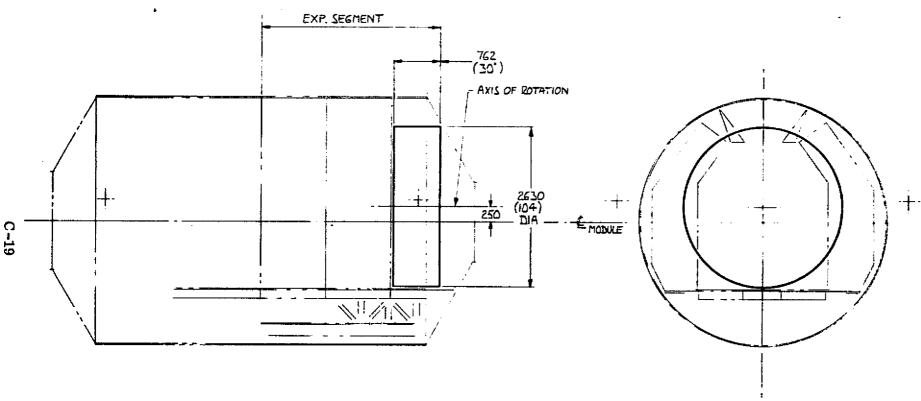
BIORESEARCH CENTRIFUGE ACCOMMODATION CONCEPT C



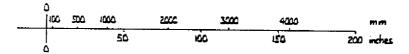
- 64 DIA CENTRIFUGE ACCOMMODATED WITHIN EXISTING EXP. SEGMENT
- NO IMPACT ON EXISTING EXP. SEGMENT STRUCTURE AND SYSTEMS
- NO LOSS OF RACK SPACE
- LOSS OF CREW SPACE 12 %



BIORESEARCH CENTRIFUGE ACCOMMODATION CONCEPT D

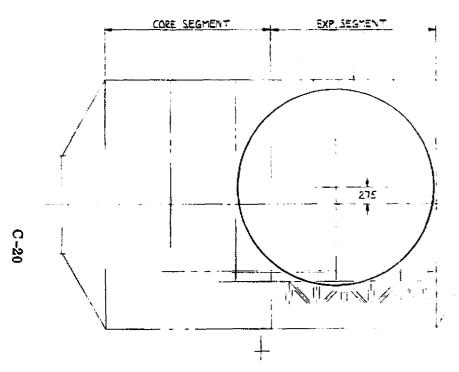


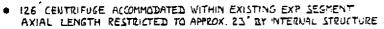
- . IQ4 DIA CENTRIFUGE ACCOMMODATED WITHIN EXISTING EXP. SEGMENT
- CEILING STRUCT MODIFIED TO CLEAR CENTRIFUGE, OTHERWISE NO IMPACT ON EXISTING EXP. SEGMENT STRUCTURE AND SYSTEMS.
- LOSS OF CREW SPACE 13%
- LOSS OF RACK SPACE 10%



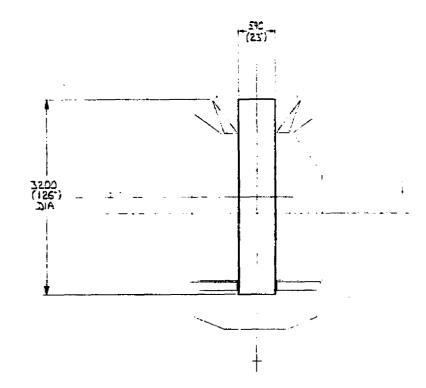
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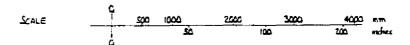
BIORESEARCH CENTRIFUGE ACCOMMODATION CONCEPT E





- . MINIMAL IMPACT ON STRUCTURE AND SYSTEMS
- . NO IMPACT ON EXISTING TRACK CAPACITY
- . MAJOR CREW SPACE IMPEDIMENT

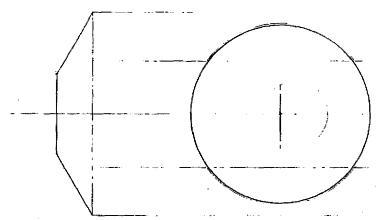


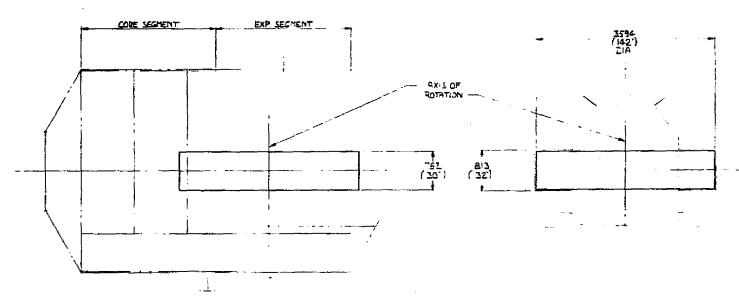


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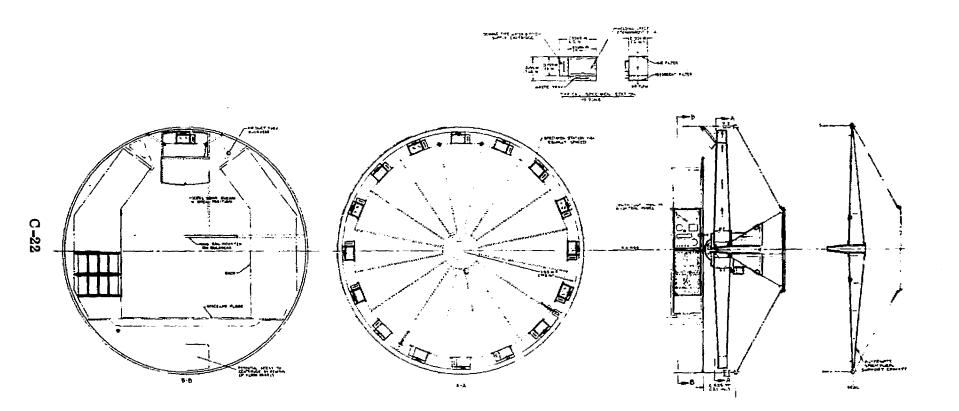




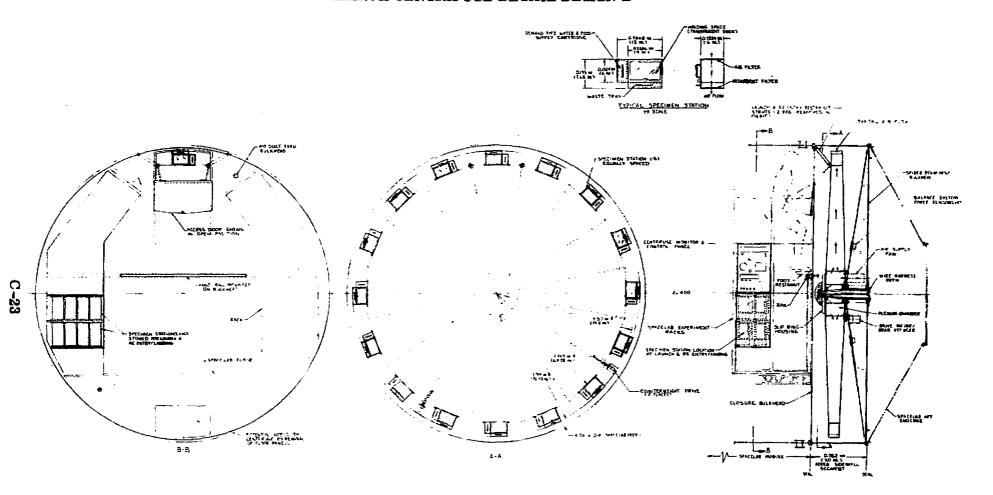
- 142 DIA CENTRIFUGE ACCOMMODATED WITHIN EXISTING EXP. SEGMENT
 FOUR DOUBLE AND FOUR SINGLE RACKS REDESIGNED TO CLEAR CENTRIFUGE ENVELOPE. LOSS OF RACK SPACE IS %
 NO IMPACT ON EXISTING EXP. SEGMENT STRUCTURE AND SYSTEMS
 MAJOR CREW SPACE IMPEDIMENT

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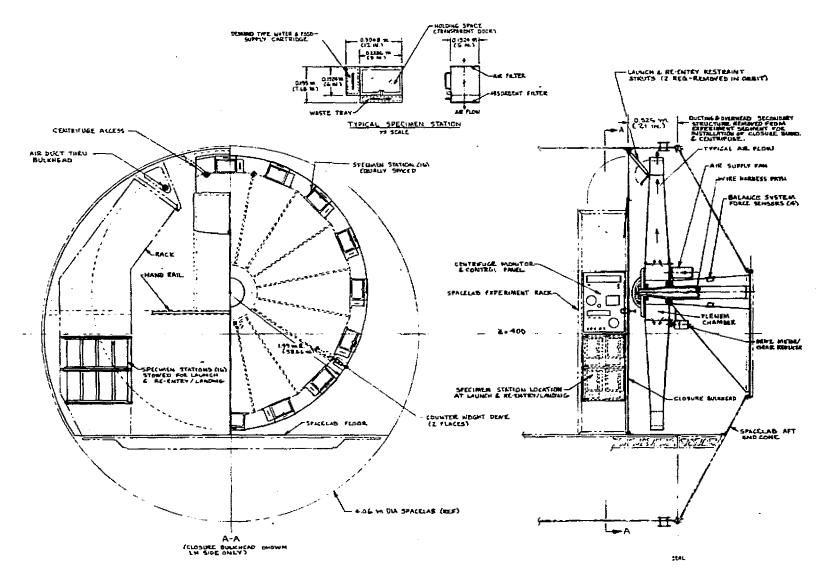
BIORESEARCH CENTRIFUGE DETAIL DESIGN A



BIORESEARCH CENTRIFUGE DETAIL DESIGN B



BIORE SEARCH CENTRIFUGE DETAIL DESIGN D



APPENDIX D

LABORATORY POWER AND ENERGY REQUIREMENTS

APPENDIX D

LABORATORY POWER AND ENERGY REQUIREMENTS

The power and energy requirements for the 16 life sciences laboratory concepts are given in this appendix. The payloads are covered in the following order.

Type	Designation	
Carry-On	Col-2A	
	Col-3A	
Mini-Lab	ML-1A (first Spacelab	mission)
	ML-2A	
	ML-3A	
	ML-4A	
	ML-5A	
	ML-2B	
	ML-2C	
	ML-2D	
Dedicated	MOD 1A	
	MOD IIA	
	MOD IIIA	
	MOD IIB	
	MOD IIC	
	MOD IIIB	

	LAB CODE: COL 2A	4		ORBIT	OPERATION	S	ASCENT	DESCENT
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution	Energy Consumption Watthrs/Day	Watts	Watts
40A		100	.10	.42	100	10	0	0
81	Freezer (-70°C)	10	24	10	10	240	10	10
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	IAB CODE: COL 3A			ORBIT	OPERATION	S	ASCENT	DESCEN
	Equipment Items Using Power	Operating Power (Watts)	On Time	Average On Duty Power	Peak Power Contribution	Energy Consumption Watthrs/Day	Watts	Waits
81	Freezer (-20°C)	10	24	10	10	240	10	10
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LAB CODE: ML-1A	,		ORBIT	OPERATION	S	ASCENT	DESCENI
Equipment Items Using Power	Operating Power (Watts)	Or Time Hrs/Day		Peak Power Contribution	Energy Consumption Watthrs/Day	Watts	Watts
6A Airflow, Work Surface	75	.2	1.25	 	15	0	0
7A Auto. Poten. Elec. Analy.	100	1	8.33	Ì	100	o	o
37 Camera, Video B/W	15	.5	. 63	15	7.5	0	0
40A Cent. Blood Sample	100	.2	1.67		20	0	0
51F Coolant Loop, Liquid	50	24	50	50	1200	0	0
63C Display Numeric	2	8	1.33	2	16		0
80 Freezer	200	8	66.67	200	1600	0	0
81 Freezer (Low Temp.)	10	24	10	10	240	10	10
114E Lamp. Port. Hi Int. Photo.	150	.5	6.25	150	75	0	0
126 Microscope	15	.5	.63	İ	7.5	0	0
126J Microscope Ass. Kit	15	.5	. 63	l	7.5	0	0
131J OFO Exp. Pack (2)	40	24	40	40	960	40	40
132 Oscilloscope	75	1	6.25	ł -	75	0	0
153A RLC/Console	127	.4	4.23	127	50.8	0	0
156 Signal Conditioners (6)	12	24	12	12	288	0	0
187A Woodlawn Wander	15	24	15	15	360	15	15
TOTALS	1001 Off Duty F	pwer = 5	224.87 223-224.	621 7 x 12 = 193	5022, 3 7	65	65
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Estimated Crew Involvement		}	}	1	<u> </u>	}	1
≈2 man-hrs/day during a 12-hour period		Ì	}	1	ļ	1	l
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	LAB CODE: ML-2A			ORBIT	OPERATION	s	ASCENT	DESCE
	Equipment Items Using Power	Operating Power (Watts)	On Time	1	1	Energy Consumition Watt-hrs/Day	Watts	Watts
	Air Part. Sampler	50	1.2	.83	 	10.0	0	.;
6A	Work Surface, Air Flow	75	2	1.25	1	15	Ö	. 0
7A	Auto, Poten, Elect. Anal.	100	1.0	8.33	100	100	o	o
30A	Cage - Rat (16)	144	12	144	144	1728	0	0
38	Camera, Video Color	69	.5	2.88	69	34.5	0	0
40A	Cent. Blood Samp.	100	. 2	1.67		20	0	0
48	Vacuum Cleaner	100	.1	. 83	1	10	0	1 0
51F	Coolant, Loop Liq.	50	24	50	50	1700	50	50
63C	Display, Numeric	2	12	2	2	24	0	0
80	Freezer, Gen.	200	8	66,67	200	1600	0	0
81	Freezer, Low Temp.	10	24	10	10	240	10	10
83	Refrigerator	50	8	16.67	50	400	0	0
91	Mass Spec.	50	1	4.17		30	o	0
103B	Incubator	5	24	5	5	120	0	o
114E	Lamp, Port. Hi Int.	150	.5	6.25	150	75	o	o
126	Microscope, Comp.	15	.5	. 63		7.5	o	0
126A	Microscope, Dissect.	100	1.0	8.33	100	100	o	0
126J	Microscope, Acc. Kit	15	.5	. 63		7.5	Ö	ő
132	Oscilloscope	75	1.0	6.25		75	0	o
156	Signal Cond. (12)	24	24	24	24	576	ŏ	0
165	Sterilizer Tool	110	.2	1.83	1	22	0	0
182P	Vent. Unit, Sm. Vert.	40	24	40	40	960	40	40
188	Work and Surgical Bench	1000	1	83.33	1000	1000	0	0
D . 1.	-10 0 0 0 0	2534	Off Duty	486.05 Power -		8374.5 05 x 12 = 211	50 . 83	50
	oad Spec 8 man/hrs/day available				12			
On	Duty - 12 hours	-						
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		%	•	:		<u> </u>	•	!
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	LAB CODE: ML-3A			ORBIT	OPERATION	S	ASCENT	DESCEN
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution		Watts	Watts
6A	Work Surface Air Flow	75	. 2	1.25		15	0	0
7A	Auto. Pot. Elec. Analy.	100	1.0	8.33	100	100	0	0
37	Video, Camera B/W	15	.5	. 63	ļ	7.5	0	0
38F	Cardiopul. Anal.	200	1	16.67	200	200	0	0
40A	Cent. Blood Sampler	100	.2	1.67	100	20	0	0
51 F	Coolant, Loop Liq.	50	24	50	50	1200	0	0
63C	Display, Numeric	2	12	2.0	2	24	0	0
70E	Physio. Exer. Equiment	18	4	6	18	72	0	0
80	Freezer, Gen.	200	8	66, 67	200	1600	0	0
81	Freezer, Low Temp.	10	24	10	10	240	10	10
83	Refrigerator	50	8	16.67	50	400	0	0
132	Oscilloscope	75	1.0	6.25	1	75	0	0
156	Signal Conditioners (6)	12	24	12.0	12	288	0	0
182	V.C.G. Coupler	2	4	. 67		8	0	6
		859		198.81	742	4249.5	10	10
		Off Duty Po	 wer - 4249		1 x 12 = 155.	} B		
	ad Specialist - 8 man/hrs/day available Duty 12 hours			12				
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	IAB CODE: ML-4A			ORBIT	OPERATION	S	ASCENT	DESCENT
	Equipment Items Using Power	Operating Power (Watts)				Energy Consumption Watthrs/Day	Watts	Watts
32	Camera, Cine	13	,5	.54		6.5	ŋ	0
37	Camera, Video B/W	15	.5	63	15	7.5	0	0
48	Cleaner, Vacuum	100	.2	1.67	100	20.0	2	; o
63C	Display, Numeric	2	8	1.33	2	16	0	0
76J	Flowmeter (4)	4	8	2.67	4	32		ļ
83	Refrigerator	50	8	16.67	50	400	0	0
87	Gas Analyzer, Infra.	50	4	16.67	50	200	0	0
91	Mass Spectrometer	50	.5	2.0	1	25.0	0	0
114E	Lamp, Port. Photo	150	1	12.5	150	150	0	0
122	Mass Meas. Device	15	.2	.25)	7.5	0	0
		449		54. 93	371	864. 5	0	0
	d Spec. 8 man/hrs/day available Duty = 12 hours		uty Power		44.93 x 12 =			

D-8

	LAB CODE: ML-2B			ORBIT OPERATIONS				DESCEN
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution	-	Watts	Watts
6	Air Part. Samp. Collector	50	.2	.83		10	0	0
6A	Work Surface, Air Flow	75	.2	1.25		15	0	0
7A	Auto. Poten. Elec. Anal.	100	1.0	8.33	100	100	0	0
38	Camera, Video Color	69	.5	2.88	69	34.5	0	0
40A	Cent. Blood Samp. Proc.	100	.2	1.67		20	0	0
48	Vacuum Cleaner	100	1.1	. 83	į	10	0	0
51 F	Coolant Loop, Liq.	50	1	50	50	1200	0	. 0
63C	Display, Numeric	2	12	2	2	24	0	0
во	Freezer, Gen.	200	8	66.67	200	1600	0	0
81	Freezer, Low Temp.	10	24	10	10	240	10	10
83	Refrigerator	50	8	16.67	50	400	0	0
91	Mass Spectrometer	50	1.0	4.17	50	50	0	0
101B	Holding Unit, Monkey Pod (2)	200/60	12/12	200	200	3120	60	60
103B	Incubator	5	24	5	5	120	0	0
114E	Lamp, Port. Hi Int.	150	.5	6.25	150	75	ا و	0
126	Microscope, Compound	15	.5	.63	1 -00	7.5	ŏ	ا ه
126J	Microscope, Acc. Kit	15	.5	. 63	1	7.5	o	0
132	Oscilloscope	75	1.0	6.25	}	75	o	lő
150B	Receiver	10	24	10	10	240	0	١٠
156	Signal Conditioners (6)	12	24	12	12	288	o	0
165	Sterilizer, Tool	110	.2	1.83	1 **	22	0	o
182P	Ventilation Unit (2)	80	24	80	80	1920	80	80
1041	ventiation out (2)		44	l				
		1528	Į.	487.89	988	9578.5	150	150
			Off Duty	Power -	9 578. 5 – 487.	9 x 12 = 310.	3	
Pay	rload Spec 8 man/hrs/day available On Duty 12 hours				12			
	•				1		}	
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	LAB CODE: ML-2C	an Maria	_: <u>_</u> .	ORBIT	OPERATION	8	ASCENT	DESCE
	Equipment Items Using Power	Operating Fower (Walls)	On Time	Average On Duty Power		Energy Consumption Watt-hrs/Day	Watts	i Watt
6	Air Part. Sampler	50	.2	.83	 	10	0	† o ···
6A	Work Surface Air Flow	75	.2	1.25 .	1	15	0	0
7A	Auto, Poten. Elec. Analy.	100	1.0	8.33	100	100	0	0
30A	Cage, Rat (16)	144	12	144	144	1728	0	0
38	Camera, Video Color	69	. 5	2.88	69	34.5	0	0
40A	Cent. Blood Samp.	100	.2	1.67	1	20	0	0
48	Vacuum, Cleaner	100	.1	.83	1	10	0	0
50	Clinostat	10	24	10	10	240	0	0
51F	Coolant Loop, Liq.	50	24	50	50	1200	0	0
54	Colony Counter	50	.5	2.08	1	25	0	0
63C	Display, Numeric	2	12	2	2	24	0	0
80	Freezer, Gen.	200	8	66.67	200	1600	0	0
81	Freezer, Low Temp.	10	24	10	10	240	10	10
83	Refrigerator	50	8	16.67	50	400	0	0
91	Mass Spectrometer	50	1.0	4.17	1	50	0	0
98A	Holding Unit C/T	50	12	50	50	600	0	0
103B	Incubator 37°C	5	24	5	5	120	0	0
114E	Lamp, Port. Hi Int.	150	.5	6.25	150	75	0	0
126	Microscope Acc. Kit	15	. 5	. 63		7.5	.0	0
126A	Microscope, Dissect.	100	1.0	8,33	100	100	0	0
126J	Microscope, Comp.	15	.5	. 63	1	7.5	0	0
132	Oscilloscope	75	1.0	6.25	ł	75	0	0
138	pH Meter	20	.1	.17	[2	0	0
156	Signal Conditions (12)	24	24	24	24	576	0.	0
165	Sterilizer, Tool	110	2	1.83		22	0	0
182P	Ventilation Unit, Sm. Vt.	40	24	40	40	960	40	40
187A	Woodlawn Wanderer	15	24	15	15	360	15	15
188	Work and Surgical Bench	1000	1	83.33	1000	1000	0	0
		2609		562.80	2019	9601.5	65	65
			Off Duty	Power = 1	601.5 - 562.	$0 \times 12 = 237.$	32	
				_	12			
	d Spec. – 8 man/hrs/day availability Duty – 12 hours	<u>!</u> ,						

	(AB CODE: ML-2D			ORBIT	OPERATION	8	ASCENT	Descen
	Equipment Items Using Power	Operating Power (Watts)	I .	, -	Peak Power Contribution		Watts	Watts
6	Air Part. Sampler	50	.2	.83		10	0	0
6A	Air Flow, Work Surface	75	. 2	1,25		15	0	0
7A	Auto. Poten. Elec. Analy.	100	1.0	8.33	100	100	0	0
30A	Cage, Rat (16)	144	12	144	144	1728	0	0
38	Camera, Video Color	69	.5	2.88	69	34.5	0	0
40A	Cent. Blood Samp. Proc.	100	.2	1.67]	20	0	0
48	Cleaner, Vacuum	100	.1	.83	}	10	0	0
50	Clinostat	10	24	10	10	240	0	0
51F	Coolant Loop, Liq.	50	24	50	50	1200	0	0
54	Colony Counter	50	.5	2.08	1	25	0	0
63C	Display, Numeric	2	12	2	2	24	1 0	0
80	Freezer, Gen.	200	8	66.67	200	1600	0	0
81	Freezer, Low Temp.	10	24	10	10	240	10	10
83	Refrigerator	50	8	16.67	50	400	0	0
91	Spectrometer, Mass	50	1.0	4.17		50	0	0
93	Gas Analyzer, H ₂ O Vapor	6	24	6	. 6	144	0	0
98A	Holding Unit C/T	50	12	50	50	600	0	o
98C	Holding Unit Invert.	50	12	50	50	600	0	0
101	Holding Unit, Plants	500	12	500	500	6000	187	18
103B	Incubator 37°C	5	24	5	5	120	0	اً وَ
114E	Lamp, Port., Hi Int.	150	.5	6.25	150	7.5	ő	Ō
126	Microscope Acc. Kit.	15	. 5	. 63]	7.5	0	0
126A	Microscope, Dissect.	100	1.0	8.33	100	100	0	0
126J	Microscope Comp.	15	.5	. 63		7.5	0 ,	0
132	Oscilloscope	75	1.0	6.25		75	0	0
138	pH Meter	20	.1	.17		2	0	0
156	Signal Conditions (12)	24	24	24	24	576	0	0
165 182P	Sterilizer, Tool Ventilation Unit. Vertical	110 40	. 2 24	1.83 40	40	22 960	0 40	0 40
187A	Woodland Wanderer	15	24	15	15	360	15	15
188	Work & Surgical Bench	1000	1	83.33	1000	1000	0	o
_00	TOTALS	3235	ļ [~]	1118,80	2625	16345.5	252	252
T	Payload Specialist - 8 man/hrs/day available		ff Duty Po		5.5 - 1118.8	0 x 12 = 243.3	3	
-	On Duty - 12 hours			_	12	!	! !	
	Co chay an area.			!	1			i F
			į		Į		÷	

	LAB CODE: MOD 1A	<u> </u>	<u> </u>	ORBIT	OPERATION	S	ASCENT	DESCEN
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day	Average On Duty Power	Peak Power Contribution	-	Watts	Watts
1A	Accelerometer Coupler (3)	3	24	3	3	72		
6	Air Particle Sampler	50	.4	1.76	İ	20		
6A	Airflow Work Surface	75	.5	3, 12	{	37.5	l	Į
7	Autoanalyzer	200	1.0	16, 66	200	200		
7A	Auto Potentiometer Elec. Analysis	100	1.0	8.34		100		1
16F	Ballistocardiogram Coupler	1	1.0	.08		1		1
19D	Body Mass Measuring Device	15	.2	.26]	3		
30A	Cage, Rat (16)	144	12	144	144	1728		
31	Calculator, Pocket	5	1.0	.42	ļ	5		
32	Camera, Cine	13	.5	. 54		6.5	j	j
32A	Camera, Controller	100	12	100	100	1200		
37	Camera, Video B/W	15	12	15	15	180		İ
38	Camera, Video, Color	69	.5	2,88	69	34.5	į	
38D	Camera Timer, Video	10	.5	42	10	5		
38F	Cardiopulmonary Analyzer	200	1.0	16.66		200	1	i
40A	Centrifuge, Blood Sample Processor	100	.4	3.34		40		
48	Cleaner, Vacuum	100	.4	3.34	Ì	40		1
50A	Clinostat C/T	10	24	10	10	240	ļ	d·
50B	Compactor (Solids)	100	. 05	.42	1	5		
51 F	Coolant Loop, Liquid	50	24	50	50	1200		1
54	Colony Counter (Manual)	50	.5	2.08	1	25		1
63B	Display Keyboard Portable	60	1.0	5.0	i	60		
63C	Display, Numeric (2)	4	12	4.0	4	48	1	}
64	ECG Coupler (12)	24	24	24	24	576	12	12
65	EEG Coupler (4)	8	24	8	8	192	4	4
6 6 C	Electrophys. Receiver	5	1.0	.42	1 °	5	*	1
66	EMG Coupler (6)	12	24	12	12	288	6	6
70 E	Exercise Equip., Physiol.	18	4	6	12	72	"	•
76J	Flowmeter, Gas (4)	16	.5	. 66	ļ	8		1 .
77B	Freezer, Cryo	10	24	10	10	240	10	10
80 80	Freezer, General	200	8	66.67	200	1600	1 ***	10
	•	10	24	10	10	240	10	10
81 83	Freezer, Low Temp.	50	8	16.67	50	400	10	10
	Refrigerator		1		1	1		
91	Gas Analyzer, Mass Spec. (2)	50	12	100	100	1200	50	50

LAB CODE: MOD 1A (Co	nt'd)		ORBIT	OPERATION	s	ASCENT	DESCEN
Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day			Energy Consumption Watt-hrs/Day	Watts	Watts
93 Gas Analyzer, RH	6	24	6	6	144		
98A Holding Unit C&T (2)	60	24	60	60	1440		60
101C Holding Unit - Primate (4)	400/120	12/12	400	400	6240	120	120
103B Incubator	5	24	5	5	120		
114E Lamp, Portable Hi. Int. Photo.	150	.5	6.16	150	75		
117 LBNP	26	,4	.86	ŀ	10.4	ļ	
121 Mass Meas. Device (Macro)	15	.3	.38		4.5		
122 Mass Meas. Device (Micro)	15	.3	.38	1	4.5		
126 Microscope, Comp.	15	.5	. 62		7.5		
126A Microscope, Dissecting	100	1.0	8.34	100	100		
126J Microscope, Access. Kit	15	.5	. 62	l	7.5		
132 Oscilloscope	75	1.0	6.26		75		
138 PH Meter	20	.3	. 50		6		İ
138B Photocell Coupler (12)	24	24	24	24	576		}
139 Plethysmograph, Limb	5	.5	.20		2.5		· ·
143G Pressure Coupler (4)	8	24	8	8	192		
147 Radiation Count - Biochemical	90	.5	3,76		45		1
150B Receiver, Biotelemetry	10	24	10	10	240		
153A Rotating Litter Chair/Console	127	.4	4.24		50.8		
156 Signa! Conditioners (12)	24	24	24	24	576	İ	1
156F Sonocardiogram	12	1.0	1.0	1	12		
162 Sterilizer, Autoclave	300	1.5	37.5	1	450	ļ	
165 Sterilizer, Tool	110	.4	3.66	}	44		İ
179 Temperature Block	200	1.5	25	290	300		
179D Thermometer (Electronic)	14	.2	. 24	1	2.8		
181D Transducer, Pressure (4)	4	24	4	4	96		[
182J Vectocardiogram Coupler	2	1.0	.16	_	2		
182P Ventilation Unit - Vertical (5)	200	24	200	200	4800	200	200
188 Work and Surgical Bench	1000	1.0	83.34	1000	1000		
TOTALS	4909		1569.96	3210	26907	412	472
On Duty is considered 12 hours.			į	!	1		1
Off Duty Average Power = 26, 907 - 1569, 90	3 x 12 - 671 20				į		ļ
12	JA 14 = 011.45	! !		:			!
12		1	•	;		: •	1

	LAB CODE: MOD HA			ORBIT	OPERATION	S	ASCENT	DESCEN	
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day	1	Peak Power Contribution	-	Watts	Watts	
1A	Accelerometer Coupler (3)	3	24	3	3	72			
6	Air Particle Sampler	50	.4	1.76		20		l l	
6A	Airflow Work Surface	75	.5	3.12	1	37.5			
7	Autoanalyzer	200	1.0	16.66	200	200		ĺ	
7A.	Auto Potentiometer Elec. Analysis	100	1.0	8.34		100		1	
16F	Ballistocardiogram Coupler	1	1.0	.08		1			
19D	Body Mass Measuring Device	15	.2	.26	j	3			
26B	Cage, Metabolic Pit. (2)	60	24	60	60	1440		60	
30A	Cage, Rat (16)	144	12	144	144	1728			
31	Calculator, Pocket	5	1.0	.42		5			
32	Camera, Cine	13	.5	. 54	1	6.5			
32A	Camera, Controller	100	12	100	100	1200			
37	Camera, Video B/W	15	12	15	15	180			
38	Camera, Video, Color	69	.5	2.88	69	34.5			
38D	Camera Timer, Video	10	.5	.42	10	5		1	
38F	Cardiopulmonary Analyzer	200	1.0	16.66		200	ļ		
10A	Centrifuge, Blood Sample Processor	100	.4	3.34		40		ļ	
48	Cleaner, Vacuum	100	.4	3.34		40		1	
50A.	Clinostat C/T	10	24	10	10	240		ì	
50	Clinostat Plants	10	24	10	10	240		i	
50B	Compactor (Solids)	100	.05	.42		5			
51F		50	24	50	50	1200			
54	Colony Counter (Manual)	50	.5	2.08		25			
63B	Display Keyboard Portable	60	1.0	5.0		60			
63C	Display, Numeric (2)	4	12	4.0	4	48		1	
64	ECG Coupler (16)	32	24	32	32	768	12	12	
65	EEG Coupler (6)	12	24	12	12	288	4	4	
65C	Electrophys. Receiver	5	1.0	.42		5		1	
66	EMG Coupler (8)	16	24	16	16	384	6	6	
70E	Exercise Equip., Physiol.	18	4	6	1	72	1	1	
765	Flowmeter, Gas (6)	24	.5	1.0	į	12	İ	1	
77B	Freezer, Cryo	10	24	10	10	240	10	10	
80	Freezer, General (2)	400	8	133.33	400	3200	į	1	
31	Freezer, Low Temp.	10	24	100.00	10	240	10	10	
33	Refrigerator (2)	100	8	33.33	100	800	1 10	10	

Using Power Power (Watts) H1	,	-	Peak Power Contribution 100 6 60	_	Watts	Watts
93 Gas Analyzer, RH 98A Holding Unit C&T (2) 98C Holding Unit Invt. (2) 101 Holding Unit Plt. (2) 1010 Holding Unit - Primate (5) 103B Incubator 114E Lamp, Portable Hi. Int. Photo. 117 LBNP 26 121 Mass Meas. Device (Macro) 122 Mass Meas. Device (Micro) 126 Microscope, Comp. 126 Microscope, Comp. 127 LBNP 128 Microscope, Access. Kit 129 Oscilloscope 120 Tis 120 Oscilloscope 121 Tis 122 Oscilloscope 1238 Photocell Coupler (12) 124 Tis 125 Tis 126 Plethysmograph, Limb	24 24 12 12 12/12	6 60 100	6 60	ŀ	50	
93 Gas Analyzer, RH 98A Holding Unit C&T (2) 98C Holding Unit Invt. (2) 101 Holding Unit Plt. (2) 1010 Holding Unit - Primate (5) 103B Incubator 114E Lamp, Portable Hi. Int. Photo. 117 LBNP 26 121 Mass Meas. Device (Macro) 122 Mass Meas. Device (Micro) 126 Microscope, Comp. 126 Microscope, Dissecting 126 Microscope, Access. Kit 132 Oscilloscope 138 PH Meter 20 138B Photocell Coupler (12) 139 Plethysmograph, Limb	24 12 12 12/12	60 100	60	144		50
98A Holding Unit C&T (2) 60 98C Holding Unit Invt. (2) 100 101 Holding Unit Plt. (2) 500/150 101C Holding Unit - Primate (5) 500/150 103B Incubator 5 114E Lamp, Portable Hi. Int. Photo. 150 117 LBNP 26 121 Mass Meas. Device (Macro) 15 122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126 Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	12 12 12/12	100				
100 101 Holding Unit Invt. (2) 1000 1000 1010 Holding Unit Plt. (2) 1000 1000 1010 Holding Unit - Primate (5) 500/150 103B Incubator 5 114E Lamp, Portable Hi. Int. Photo. 150 117 LBNP 26 121 Mass Meas. Device (Macro) 15 122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126 Microscope, Comp. 15 126 Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	12 12/12		1	1440		
101 Holding Unit Pit. (2) 1000 101C Holding Unit - Primate (5) 500/150 103B Incubator 5 114E Lamp, Portable Hi. Int. Photo. 150 117 LBNP 26 121 Mass Meas. Device (Macro) 15 122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	12/12	1000	100	1200		1
101C Holding Unit - Primate (5) 500/150 103B Incubator 5 114E Lamp, Portable Hi. Int. Photo. 150 117 LBNP 26 121 Mass Meas. Device (Macro) 15 122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5			1000	12000	374	374
103B Incubator 5 150 150 114E Lamp, Portable Hi. Int. Photo. 150 117 LBNP 26 121 Mass Meas. Device (Macro) 15 122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	94	500	500	7800	150	150
114E Lamp, Portable Hi. Int. Photo. 150 117 LBNP 26 121 Mass Meas. Device (Macro) 15 122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	44	5	5	120		İ
117 LBNP 26 121 Mass Meas. Device (Macro) 15 122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	.5	6.16	150	75		į
121 Mass Meas. Device (Macro) 15 122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	.4	. 86		10.4		
122 Mass Meas. Device (Micro) 15 126 Microscope, Comp. 15 126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	.3	. 38		4.5		
126 Microscope, Comp. 15 126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	.3	.38		4.5		
126A Microscope, Dissecting 100 126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	.5	. 62		7.5		
126J Microscope, Access. Kit 15 132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	1.0	8.34	100	100		
132 Oscilloscope 75 138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	.5	. 62	•	7.5		İ
138 PH Meter 20 138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	1.0	6.26		75		l
138B Photocell Coupler (12) 24 139 Plethysmograph, Limb 5	.3	. 50		6		
139 Plethysmograph, Limb 5	24	24	24	576		
	.5	. 20		2,5		
	.5	1.25		7.5		
	24	8	. 8	192		ļ
	.5	3.76		45		
	24	10	10	240		
	.4	4.24		50.8		
	24	32	32	768		ŀ
<u> </u>	1.0	1.0	•	12		
*	1.5	37.5	1	450		
165 Sterilizer, Tool 110	.4	3.66	}	44		
	1.5	25	200	300		
179D Thermometer (Electronic) 14	.2	. 24		2.8		1
	24	4	4	96		
	1.0	.16		2		
	24	240	240	5760	240	240
· · · · · · · · · · · · · · · · · · ·	1.0	83.34	1000	1000		
TOTALS 6566	5- 2988. 8	2988.89 9 x 12	4794 918	4688.25	856	976

	LAB CODE: MOD III A	.		ORBIT	OPERATION	5	ASCENT	DESCENI
; ;	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power	Energy Consumption Watt-hrs/Day	Watts	Watts
1A	Accelerometer Coupler (3)	3	24	3	3	72		İ
6	Air Particle Sampler	50	.4	1.76	ŀ	20		
6A	Airflow Work Surface	75	.5	3.12		37.5	}	
11	Analyzer, Gen. Spect'phot'r.	250	1	20.5	250	250		
7	Autoanalyzer	200	1.0	16.66	200	200		
7A.	Auto Potentiometer Elec. Analysis	100	1.0	8.34		100		
16F	Ballistocardiogram Coupler	1	1.0	.00	i	1	}	Ì
19D	Body Mass Measuring Device	15	. 2	.26		3		
26A	Cage, Metabolic C/T	5	24	5	5	120		
26B	Cage, Metabolic Plt. (2)	60	24	60	60	1440		60
28	Cage, Metabolic Rat	20	24	20	20	480]	20
30A	Cage, Rat (16)	144	12	144	144	1728]	
31	Calculator, Pocket	5	1.0	.42	 	5	į	
32	Camera, One	13	. 5	. 54	1	6.5		
32A	Camera, Controller	100	12	100	100	1200		
37	Camera, Video B/W	15	12	15	15	180	i	•
38	Camera, Video, Color	69	.5	2.88	69	34.5		
38D	Camera Timer, Video	10	. 5	.42	10	5		
38F	Cardiopulmonary Analyzer	200	1.0	16.66		200	ĺ	
40A	Centrifuge, Blood Sample Processor	100	.4	3.34		40		
43A	Centrifuge - Research △	354/210	12/12	354	354	6768	1	1
48	Cleaner, Vacuum	100	.4	3.34	1	40		1
50A	Clinostat C/T	10	24	10	10	240]
50	Clinostat Plants	10	24	10	10	240	1	
50B	Compactor (Solids)	100	. 05	.42		5		
51 F	Coolant Loop, Liquid	50	24	50	50	1200	ŀ	
54	Colony Counter (Manual)	50	. 5	2.08		25		
63B	Display Keyboard Portable	60	1.0	5.0		60		
63C	Display, Numeric (3)	6	12	6	6	72		
64	ECG Coupler (24)	48	24	48	48	1152	12	12
65	EEG Coupler (8)	16	24	16	16	384	4	4
6 6C	Electrophys. Receiver	5	1.0	.42	1	5	_]
66	EMG Coupler (10)	20	24	20	20	480	6	6
70E	Exercise Equip., Physiol.	18	4	6	1	72	_	
76J	Flowmeter, Gas (6)	24	. 5	1.0		12		

	LAB CODE: MOD IIIA (Cont's	d)		ORBIT	OPERATION	5	ASCENT	DESCEN
·	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution	Energy Consumption Watthrs/Day	Watts	Watts
77B	Freezer, Cryo	10	24	10	10	240	10	10
80	Freezer, General (2)	400	8	133.33	400	3200		1
81	Freezer, Low Temp. (2)	20	24	20	20	480	20	20
83	Refrigerator (2)	100	8	33.33	100	800		
87	Gas Analyzer, Infrared	50	.5	4.16		25	}	
91	Gas Analyzer, Mass Spec. (2)	100	12	100	100	1200	50	50
93	Gas Analyzer, RH	6	24	6	6	144		
98A	Holding Unit C&T (2)	60	24	60	60	1440		60
98C	Holding Unit, Invt. (2)	100	12	100	100	1200	1	
101	Holding Unit, Plt. (2)	1000	12	1000	1000	12000	374	374
1	Holding, Unit, Monkey Pod	100/30	12/12	100	100	1560	30	30
	Holding Unit - Primate (1)	100/30	12/12	100	100	1560	30	30
	Incubator	5	24	5	5	120		"
114E	Lamp, Portable Hi. Int. Photo.	150	.5	6.16	150	75		1
117	LBNP	26	.4	.86	1	10.4		1
121	Mass Meas. Device (Macro)	15	.3	.38	,	4.5	ļ	
122	Mass Meas. Device (Micro)	15	.3	.38	{	4.5		1
126	Microscope, Comp.	15	. 5	.62	!	7.5	i	ŀ
ı	Microscope, Dissecting	100	1.0	8.34	100	100		
126J	Microscope, Access. Kit	15	.5	.62	ļ	7.5		1
132	Oscilloscope	75	1.0	6.26		75	}	j
138	PH Meter	20	.3	. 50	•	6		j
138B	Photocell Coupler (12)	24	24	24	24	576	1	1
139	Plethysmograph, Limb	5	. 5	. 20	[2.5		1
143G	Pressure Coupler (4)	8	24	8	8	192	1	
144	Psychomotor Per. Cons.	15	.5	1.25		7.5		
147	Radiation Count - Biochemical	90	. 5	3.76		45	1	
150B	Receiver, Biotelemetry	10	24	10		240	1	-
4	Rotating Litter Chair/Console	127	.4	4.24	ļ	50.8	{	
156	Signal Conditioners (24)	48	24	48	48	1152	j	1
156F	Sonocardiogram	12	1.0	1.0		12	1	1
162	Sterilizer, Autoclave	300	1.5	37.5	Ī	450		
165	Sterilizer, Tool	110	.4	3.66	, 1	44		-
179 179D	Temperature Block Thermometer (Electronic)	200 14	1.5	25 .24	200	300 2.8		!

LAB CODE: HIA (Cont d)			ORBIT	OPERATION:	5	ASCENT	DESCENT
Equipment items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution		Watts	Watts
181D Transducer, Pressure (4)	4	24	4	4	96	·	
182J Vectocardiogram Coupler	2	1.0	.16		2	ļ	
182P Ventilation Unit - Vertical (3)	120	24	120	120	2880	120	120
188 Work and Surgical Bench	1000	1.0	83.34	1000	1000		
TOTALS	6896		3034.55	5056	48189.5	656	696
On Duty is considered 12 hours.				į	į		
Off Duty Average Power = 48,189.5 - 3034.55	x 12 = 981.2				 -		
△ For 182R in Centrifuge 43A	320		320	320	3840		
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	LAB CODE: MOD IIB	<u> </u>		ORBIT	OPERATION	5	ASCENT	DESCENI
	•			Average		Energy		
	Equipment Items	Operating	On Time	On Duty	Peak Power	Consumption]	
	Using Power	Power (Watts)	Hrs/Day	Power	Contribution	Watt-hrs/Day	Watts	Watts
1A	Accelerometer Coupler (3)	3	24	3	3	72		
6	Air Particle Sampler	50	.4	1.76	İ	20		
6A	Airflow Work Surface	75	. 5	3.12		37.5		1
7	Autoanalyzer	200	1.0	16,66	200	200		
7A	Auto Potentiometer Elec. Analysis	100	1.0	8.34	ļ	100		
16F	Ballistocardiogram Coupler	1	1.0	.08	•	1	İ	
19D	Body Mass Measuring Device	15	. 2	.26	ľ	3		1
26B	Cage, Metabolic Plt. (2)	60	24	60	60	1440	•	60
28	Cage, Metabolic Rat	20	24	20	20	480	ŀ	20
30A	Cage, Rat (16)	144	12	144	144	1728		
31	Calculator, Pocket	5	1.0	.42		5		Ì
32	Camera, Cine	13	.5	. 54		6.5		
32A	Camera, Controller	100	12	100	100	1200		
37	Camera, Video B/W	15	12	15	15	180		, ·
38	Camera, Video, Color	69	.5	2.88	69	34,5		
38D	Camera Timer, Video	10	. 5	.42	10	5		
38F	Cardiopulmonary Analyzer	200	1.0	16.66		200		1
40A (Centrifuge, Blood Sample Processor	100	.4	3.34		40		
48	Cleaner, Vacuum	100	.4	3.34		40		
50A	Clinostat C/T	10	24	10	10	240		1
50	Clinostat Plants	10	24	10	10	240		1
50B	Compactor (Solids)	100	.05	.42		5		
51 F	Coolant Loop, Liquid	50	24	50	50	1200		
5 4	Colony Counter (Manual)	50	.5	2.08		25		
63B	Display Keyboard Portable	60	1.0	5.0		60-		}
СвС	Display, Numeric (2)	4	12	4.0	4	48		İ
64	ECG Coupler (12)	24	24	24	24	576	12	12
65	EEG Coupler (4)	8	24	8	8	192	4	4
66	EMG Coupler (6)	12	24	12	12	288	6	6
70E	Exercise Equip., Physiol.	18	4	6		72		
76J	Flowmeter, Gas (4)	16	.5	.66		8		
77B	Freezer, Cryo	10	24	10	10	240	10	10
80	Freezer, General	200	8	66,67	200	1600		
81	Freezer, Low Temp.	10	24	10	10	240	10	10
83	Refrigerator	50	8	16.67	50	400		

	LAB CODE: MOD IIB (Co	nt d)		ORBIT	OPERATION:	3	ASCENT	DESCEN
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day	_	Peak Power Contribution	Energy Consumption Watt-hrs/Day	Watts	Watts
91 G	as Analyzer, Mass Spec. (2)	100	12	100	100	1200	50	50
	as Analyzer, RH	6	24	6	6	144	00	"
98A H	olding Unit C&T (2)	60	24	60	60	1440		60
98C H	olding Unit Invt. (2)	100	12	100	100	1200		1
101 H	olding Unit Plt. (2)	1000	12	1000	1000	12000	374	374
10 1 CH	olding Unit - Primate (4)	200/60	12/12	200	200	3120	60	60
103B I	ncubator	5	24	5	5	120		
	Lamp, Portable Hi. Int. Photo.	150	.5	6.16	150	75		
117	LBNP	26	.4	.86	{	10.4		1
121	Mass Meas. Device (Macro)	15	.3	. 38	•	4.5		
122	Mass. Meas. Device (Micro)	15	.3	.38		4.5	1	
126	Microscope, Comp.	15	.5	.62		7.5		
126A	Microscope, Dissecting	100	1.0	8.34	100	100		
126J.	Microscope, Access, Kit	15	.5	. 62	•	7.5		1
132	Oscilloscope	75	1.0	6.26	1	75		1
138	PH Meter	29	.3	. 50	•	6		l
138B	Photocell Coupler (12)	24	24	24	24	576		1
139	Plethysmograph, Limb	5	.5	.20		2.5		į.
	Pressure Coupler (4)	8	24	8	8	192		1
150B	Receiver, Biotelemetry	10	24	10	10	240		ŀ
156	Signal Conditioners (12)	24	24	24	24	576		1
156F	Sonocardiogram	12	1.0	1.0		12		
162	Sterilizer, Autoclave	300	1.5	37.5	1	450		1
165	Sterilizer, Tool	110	.4	3.66		44		1
179	Temperature Block	200	1.5	25	200	300		ļ
179D	Thermometer (Electronic)	14	.2	.24	İ	2.8		
181D	Transducer, Pressure (4)	. 4	24	4	4	96]
182J	Vectocardiogram Coupler	2	1.0	. 16	ĺ	2]	1
182P	Ventilation Unit - Vertical (2)	80	24	80	80	1920	80	80
182R	Vertebrate ECS	320	24	320	320	7680	320	320
188	Work and Surgical Bench	1000	1.0	83.34	1000	1000		l
	TOTALS	5927	1	2751.54	4400	43834	926	1066
	On Duty is considered 12 hours.			1		1		
	Off Duty Average Power = 43,834 - 2751.54	$\frac{12}{12} = 901.3$					i i	

	LAB CODE: MOD IIC			ORBIT	OPERATION	S	ASCENT	DESCENT
				Average		Energy		
	Equipment Items	Operating	On Time		Peak Power		}	
	Using Power	Power (Watts)	Hrs/Day	: -	Contribution	-	Watts	Watts
1A	Accelerometer Coupler (3)	3	24	3	3	72		
6	Air Particle Sampler	50	.4	1.76		20		}
6A.	Airflow Work Surface	75	.5	3.12	İ	37.5		ł
7	Autoanalyzer (Minitized)	200	1.0	16.66	200	200	ļ	
7A	Auto Potentiometer Elec. Analysis	100	1.0	8.34		100	•	
16F	Ballistocardiogram Coupler	1	1.0	.08	1	1	Į.	
19D	Body Mass Measuring Device	15	.2	.26	i	3	1	
30A	Cage, Rat (16)	144	12	144	144	1728		
31	Calculator, Pocket	5	1.0	.42	1	5		ļ.
32	Camera, Cine	13	. 5	.54	Į	6.5	[
32A	Camera, Controller	100	12	100	100	1200	}	
37	Camera, Video B/W	15	12	15	15	180		
38	Camera, Video, Color	69	.5	2.88	69	34.5		ŀ
38D	Camera Timer, Video	10	.5	.42	10	5	1	
38F	Cardiopulmonary Analyzer	200	1.0	16.66		200		1
40A	Centrifuge, Blood Sample Processor	100	.4	3.34		40		1
48	Cleaner, Vacuum	100	.4	3.34	1	40		
50B	Compactor (Solids)	100	.05	.42	1	5	ļ	
51F	Coolant Loop, Liquid	50	24	50	50	1200	ŀ	1
54	Colony Counter (Manual)	50	.5	2.08		25		
63B	Display Keyboard Portable	60	1.0	5.0	1	60		
63C	Display, Numeric (2)	2	12	2	2	24		1
64	ECG Coupler (12)	24	24	24	24	576	12	12
65	EEG Coupler (4)	8	24	8	8	192	4	4
66	EMG Coupler (8)	12	24	12	12	288	6	6
70E	Exercise Equip., Physiol.	18	4	¹ 6	1	72		
76J	Flowmeter, Gas (4)	16	.5	.66	1	8		
77B	Freezer, Cryo	10	24	10	10	240	10	10
80 80	Freezer, General (2)	400	8	133.34	400	3200		
81	Freezer, Low Temp.	10	24	10	10	240	10	10
8 3	Refrigerator (2)	100	8	33.34	100	800		1
91	Gas Analyzer, Mass Spec. (2)	100	12	100	100	1200	50	50
_	- · · · · · · · · · · · · · · · · · · ·	6	24	6	6	144	}	-
93	Gas Analyzer, RH	100/30	12/12	100	100	1560	30	30
101B	Holding Unit Monkey Pod	100/30	1 10/10				:	

	LAB CODE: MOD IIC (Cont	(g)		ORBIT	OPERATION	S	ASCENT	DESCENT
; } }	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution		Watts	Watts
101C	Holding Unit - Primate (2)	200/60	12/12	200	200	3120	60	60
114E	Lamp, Portable Hi. Int. Photo.	150	5	6.16	150	75		
117	LBNP	26	.4	.86		10.4		
121	Mass Meas, Device (Macro)	15	.3	.38		4.5		1
122	Mass Meas. Device (Micro)	15	.3	.38		4.5		
126	Microscope, Comp.	15	. 5	. 62		7.5		
126A	Microscope, Dissecting	100	1.0	8.34	100	100		}
126J	Microscope, Access. Kit	15	.5	. 62		7.5		
132	Oscilloscope	75	1.0	6.26		75		
138	PH Meter	20	8.	. 50		6		
138B	Photocell Coupler (12)	24	24	24	24	576		r i
139	Plethysmograph, Limb	5	.5	. 20		2.5		1
143G	Pressure Coupler (4)	8	24	8	8	192		1
150B	Receiver, Biotelemetry	10	24	10	10	240	İ	}
156	Signal Conditioners (16)	32	24	32	32	768	i	1
156F	Sonocardiogram	12	1.0	1.0		12		1
162	Sterilizer, Autociave	300	1.5	37.5		450		
165	Sterilizer, Tool	110	.4	3.66	1	44		
179	Temperature Block	200	1.5	25	200	300	ļ	1
179D	Thermometer (Portable)	14	. 2	. 24	ļ	2.8		
181D	Transducer, Pressure (4)	4	24	4	4	96	Ì	
182J	Vectocardiogram Coupler	2	1.0	. 16		2		
182P	Ventilation Unit - Vertical (2)	80	24	80	80	1920	80	80
182R	Vertebrate ECS	320	24	320	320	7680	320	320
188	Work & Surgical Bench	1000	1.0	83.34	1000	1000	582	582
	TOTALS	5018		1675, 88	3491	30402	984	364
	On Duty is considered 12 hours.		1	l		}		
	Off Duty Average Power = 30402 - 1675, 88	12 = 857.6	1		1			1
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	LAB CODE: MOD HIB	-		ORET	OPERATION	S	ASCENT	DESCEN
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day	-	Peak Power Contribution	Energy Consumption Wathrs/Day	Watts	Watts
1A	Accelerometer Coupler (3)	3	24	3	3	72	 	
6	Air Particle Sampler	50	.4	1.76]	20	}	1
6A	Airflow Work Surface	75	. 5	3.12	Ì	37.5		
7	Autoanalyzer	200	1.0	16.66	200	200	1	•
7A	Auto Potentiometer Elec. Analysis	100	1.0	8.34		100	1	ļ
16F	Ballistocardiogram Coupler	1	1.0	.08		1	1	1
19D	Body Mass Measuring Device	15	.2	.26		3]	}
28	Cage, Metabolic Rats	20	24	24	20	480		}
30A	Cage, Rat (16)	144	12	144	144	1728]	•
31	Calculator, Pocket	5	LO	.42	l	5		}
32	Camera, Cine	13	.5	. 54	1	6.5		1
32A	Camera, Controller	100	12	100	100	1200	1	
37	Camera, Video B/W	15	12	15	15	180	1	
38	Camera, Video, Color	69	.5	2.88	69	34.5	1	1
38D	Camera Timer, Video	10	. 5	.42	10	5	ŀ	1
38F	Cardiopulmonary Analyzer	200	1.0	16.66	}	200		1
40A	Centrifuge, Blood Sample Processor	100	.4	3.34	1	40 .		
43A	Centrifuge L. S. Res.	354/210	1211.2	354	354	6768		ſ
48	Cleaner, Vacuum	100	.4	3.34		40	}	1
50B	Compactor (Solids)	100	. 05	.42	<u> </u>	5	İ	
51F	Coolant Loop, Liquid	50	24	50	50	1200	ļ	<u> </u>
54	Colony Counter (Manual)	50	.5	2.08		25		
63B	Display Keyboard Portable	60	1.0	5.0	}	60 .		
63C	Display, Numeric (2)	2	12	2.0	2	24		
64	ECG Coupler (16)	32	24	32	32	768	12	12
65	EEG Coupler (8)	16	24	16	16	384	4	4
66	EMG Coupler (8)	16	24	16	16	384	6	6
70E	Exercise Equip., Physiol.	18	4	6		72		
76J	Flowmeter, Gas (6)	24	.5	1.0	Í	12		1
77B	Freezer, Cryo	10	24	10	10	240	10	10
80 80	Freezer, Cryo Freezer, General (2)	400	8	133.34	400	3200	10	10
	, , ,	10	24	10	10	240	10	10
81	Freezer, Low Temp. Refrigerator (2)	100	8	33.34	100	800	10	1 1
83 91	Gas Analyzer, Mass Spec. (2)	100	12	100	100	1200	50	50
91	Gas Allalyzer, mass opec. (2)	100						

	LAB CODE: MOD HIB (Cont's	d)		ORBIT	OPERATION'S	5	ASCENT	DESCENT
	Equipment Items Using Power	Operating Power (Watts)	On Time Hrs/Day		Peak Power Contribution	_	Watts	Watts
93	Gas Analyzer, RH	6	24	6	6	144		·
114E	Lamp, Portable Hi. Int. Photo.	150	.5	6.16	150	75] .
117	LBNP	26	.4	.86		10.4		1
121	Mass Meas. Device (Macro)	15	.3	.38	}	4.5	ļ	
122	Mass Meas. Device (Micro)	15	.3	.38	1	4.5		
126	Microscope, Comp.	15	.5	.62		7.5		
126A	Microscope, Dissecting	100	1.0	8.34	100	100		1
126J	Microscope, Access. Kit	15	. 5	. 62		7.5		
132	Oscilloscope	75	1.0	6.26		75		
138	PH Meter	20	.3	.50		6		
138B	Photocell Coupler (12)	24	24	24	24	576	ł	
139	Plethsymograph, Limb	5	.5	.20		2.5		1
1	Pressure Coupler (4)	8	24	8	8	192	ļ	
150B	Receiver, Biotelemetry	10	24	10	10	240		· ·
156	Signal Conditioners (12)	32	24	32	32	768	1	
156F	Sonocardiogram	12	1.0	1.0	1	12		
162	Sterilizer, Autoclave	300	1.5	37.5	1	450		
165	Sterilizer, Tool	110	.4	3.66	1	44		1
179	Temperature Block	200	1.5	25	200	300	i .	
179D	Thermometer (Electronic)	14	.2	.24	1	2.8		
181D	Transducer, Pressure (4)	4	24	4	4	96		
182J	Vectocardiogram Coupler	2	1.0	.16	1	2		
182R	Vertebrate ECS	320	24	320	320	7680	320	320
188	Work and Surgical Bench	1000	1.0	83.34	1000	1000	l	
	TOTALS	5040		1690.22	3505	31524	412	412
	On Duty is considered 12 hours.			1				
	Off Duty Average Power = 31, 524 - 1690.22 x	12 = 936, 78	1					
	12		l					
	For 182R in Centrifuge 43A	320	ļ	320	320	3840		· .

APPENDIX E LABORATORY SAMPLED DATA REQUIREMENTS

APPENDIX E

LABORATORY SAMPLED DATA REQUIREMENTS

The sampled data requirements for the life sciences laboratory concepts are given in this appendix. Three of 16 payloads defined in the study, COL 2A, COL 3A and ML-5A have no sampled data requirements. Data for these are taken manually. The requirements for the other 13 payloads are covered in the following order.

Mini-Lab	ML-1A ML-2A ML-3A ML-4A ML-2B ML-2C ML-2D
Dedicated	MOD IA MOD IIIA MOD IIB MOD IIC MOD IIIB

PAYLOAD FIRST US/ESA SPACELAB MISSION NO. M-L.1A

<u> </u>							S	UP: NEE	PO:	RT SD			
EI	NA ME	MEASUREMENT DESCRIPTION	FREQ. OF	DURATION OF OPERATION	CONTINUOUS DATA RATE. bos	DAILY TOTAL, bits	meh	Ancont	On-orthit	Descent	Post-launch	PROCESSING REQUIRED	REMARKS
7A		Measure pH, pCO ₂ , pO ₂ , K, Ca, Na, Cl, glucose	2/day	0.5 hr	Negl.	5 K		ı	x			Conversion to cone. values. Downlink.	
80,81	Freezers	Monitor temperatures	Once/10 min.	-	Negl.	зк			×	×	*	Out-of-tolerance determination.	
131J	OFO Experiment Packages	8 Otolith signals 4 ECG signals Housekeeping	1/day	24 hr.	100 K	8640 M	x	x		x	x	Transmission to ground. Real-time or near real-time.	Otolith channels sample at 2000 samples/sec; ECG at 500 sps.
153A	Rotating Litter Chair	EOG/EMG, Controls	2/mission	0.5 br Max. I	6.5 K ate 106 KBPS	11.7 M 8650 M			×			Transmission to ground.	
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			ł	DURATION	CONTINUOUS	DAILY	Ē	뒽	훈	ğ		
EI	NAME	MEASUREMENT DESCRIPTION	FREQ. OF	OF OPERATION	DATA RATE,	TOTAL,	į	RCG	P F	Descont	PROCESSING REQUIRED	REMARKS
7A	Auto. Potent, Elec.	Measure pH, pCO ₂ , pO ₂ , K, Ca, Na,	2/day	0.5 hr	bos Negl.	5 K	盲	Ħ	×		Conversion to conc. values.	LEMANTA
ļ	Anal.	Cl, glucose	2,429	0.0 m	11641.	JR			Î		Downlink.	·
156	Signal Conditioners (12)	Monitor electrophysiological outputs such as ECG, EEG, etc.	24/day 6/day	10 min. 10 min.	3500/6 Chnl. 700/6 Chanl.	302.4 M 15.1 M	×	×	×	x)		6 channels - 500 samples, sec. 6 channels -
	(12)	such as ecc, erg, ecc.	6/цау	IV mm.	70076 Chani.	318 M					Possibly some waveform analysis/ compression.	100 samples/sec.
80/81/ 83	Freezers/Refrig.	Monitor temperatures	Once/10 min.		Negl.	3 K	×	x	x	x ,	Out-of-tolerance determination.	12 charmels, 5 bit/chnl.
103B	Incubator	Monitor temperatures	Once/15		Negl.	1.5 K			×		Out-of-tolerance determination.	
			min.					H	ı		• .	
182 P	Ventilation Unit, Vertebrates	Monitor Nows, pressures, humidi- ties, etc., 3 sensors.	Once/min.	-	Negi.	22 K	*	×	x	x x	Out-of-tolerance determination.	
91	Mass Spectrometer	Monitor mass no. and peaks of trace contaminant and major atmospheric gases.		Continuous	600	52 M	×	x	x	×	Transmission to ground. Possibly some waveform analysis.	
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PAYLOAD BIOMEDICINE - MAN NO. M-L 3A

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£1	NAME	MEASUREMENT DESCRIPTION	FREQ. OF	DURATION OF OPERATION	CONTINUOUS DATA RATE, bbs	DAILY TOTAL, bits	Pro-launch				PROCESSING REQUIRED	REMARKS
		Measure pH, pCO ₂ , pC ₂ , K, Ca, Na, Cl, glucose		0.5 hr.	Negl.	5K		7	T		Conversion to cone. values. Downlink.	
156	Signal Conditioners (6)	Monitor electrophysiological outputs such as ECG, EEG, etc.	3/day	1.0 hr	3500/3 Ciml. 700/3 Ciml.	113.4M <u>22.7M</u> 136M		,			Downlink, Possible on-board waveform analysis/compression.	nciodes VCG coupler.
80/81/ 83	Preczers/Refrig.	Monitor temperatures.	Once/10		Negl.	9 K		}	,	*	Out-of-tolerance determination.	
38F	Cardiopulmonary Analyzer	Measure H ₂ O, N ₂ , C ¹⁸ O, O ₂ , A, CO ₂ , N ₂ O gases on breath-by-breath basis.	2/day	0.5 hr	500/6 chals	10.8M					Conversion to conc. values. Downlink.	
18C	Exercise Equit., Physiological	Monitor ergometer speed, output. Treadmill speed. Assume 4 chals.	2/day	1.0 hr	5/4 chals	144K		-			Downitak, onhoard display and control.	Assume 4 cinis. 1 sample/sec.
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1			FREQ. OF	DURATION OF	CONTENUOUS DATA RATE,	DAILY TOTAL			ВССП	18		
El	NA ME	MEASUREMENT DESCRIPTION		OPERATION		bits	ā.	ξ [δ	٤	Ŗ,	PROCESSING REQUIRED	REMARKS
93A	Gas Supplies	Monitor pressures (3)	Once/min		Negl.	21.6K		×			Out-of-tolerance determination.	
87	Gas Analyzer, Infrared	Measures concentration of gas constituents.		Continuous	10	864K		×			Out-of-tolerance determination. Selected conc. display.	
91	Mass Spectrometer	Monitor mass no. and peaks of trace contaminant & major atmospheric gases.		Continuous	600	52M		x			Downlinking. Possibly some on- board analysis and display.	
83	Refrigerator	Monitor temperatures.	Once/10 min		Negl.	1.5K		×			Out-of-telerance determination.	
115F	LSS Test Console	Monitor temps., pressures, flows, currents, etc. Assume 10 chls.	Once/10 sec	12 hrs-10 chis; 12 hrs-2 chis	5 1	216K 43K 259K		×			Out-of-tolerance determination. Downlink sup. data. Trend analysis.	; ;
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PAYLOAD BIOMEDICINE/BIOLOGY - PRIMATE MINI-LAB NO. M-L 2B

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EI	NAME	MINESTER DESCRIPTION	FREQ. OF	DURATION OF	DATA RATE,	DAILY TOTAL.					ost-launch	PROCESSING REQUIRED	Between
				OPERATION	bos	l :	-	Š	۲	+	-		REMARKS
7A	Auto. Poten, Elec. Anal	Measure pH, pCO ₂ , pO ₂ , K, Ca, Na, Cl, glucose	2/day	0.5 hr.	Negl.	5K			x			Conversion to cose, values. Downlink.	
156	Signal Conditioners (6)	Monitor electrophysiological outputs such as ECG, EEG, etc.	24/day 6/day	10 min. 10 min.	3500/3 Chnl. 700/3 Chnl.	151.2M 7.6M 159M		x	X	×	×	Transmission to ground. Possibly some waveform analysis/ compression.	3 - 500 samples/şec chis. 3 - 190 samples/ sec chis.
80/81	Freezers	Monitor temperatures.	Once/10 min.		Negi.	6K			×	×	X	Out-of-tolerance determination.	8 channels, 5 bit/chal.
103B	Incubator	Monitor temperatures	Once/5 min.		Negl.	1.5K			×			Out-of-tolerance determination.	
91	Mass Spectrometer	Monitor mass no. and peak height of trace contaminant and major atmospheric gases.		Continuous	600	52M	x	x	x	x	*	Transmission to ground. Possibly some waveform analysis.	
83	Refrigerator	Monitor temperatures	Once/10 min.		Negl.	3K	x	x	x	*	×	Out-of-tolerance determination.	
182P	Ventilation Unit, Vertebrates	Monitor flows, pressure, humidities, etc. Est. 6 sensors.	Once/min.		Negl.	49K	x	x	×	×	×	Out-of-tolerance determination.	
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PAYLOAD BIOMEDICINE/BIOLOGY MINI-LAB - SMALL VERTS./CELLS & TISSUES NO. M-L 2C

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				DURATION	CONTENUOUS	DAILY	{ - =	Ĭ	Įŝ	8	1		l
EI	NA ME	MEASUREMENT DESCRIPTION	FREQ. OF OPERATION	of operation	DATA RATE,	TOTAL, bits	Pre-lameh	Ascent	δ	Descent	Pos	PROCESSING REQUIRED	REMARKS
7A	Auto, Poten, Elec, Anal	Measure pit, pCO ₂ , pO ₂ , K, Ca, Na, CI, glucose	2/day	0.5 hr.	Negi.	5K			×			Conversion to cone. values. Downlink.	·
156	Signal Conditioners (12)	Monitor electrophysiological outputs such as ECG, EEG, etc.	24/day 6/day	10 min. 10 min.	3500/6 Chal. 700/6 Chal.	302.4M 15.1M 318 M	ж	×	×	X	x	Transmission to ground. Possibly some waveform analysis/compression.	6 chais - 500 samples/ sec. 6 chamels - 10) samples/sec.
80/81/ 83	Freezers/Refrig.	Monitor temperatures.	Once/10 min.		Negl.	9 K	×	×	×	×	Ξ	Out-of-tolerance determination.	2 chansals, 5 bit/ciml.
103B	Incubator	Monitor temperatures	Once/15 min.		Negl.	1.5K			Ŧ			Out-of-tolerance determination.	
182P	Ventilation Unit, Vertebrates	Monitor flows, pressures, humidi- ties, etc., 3 sensors.	Once/min.		Negl.	22K	-	Ļ	z	×	×	Out-of-tolerance determination.	
98A	Holding Unit, C&T	Monitor temp.	Once/min.		Negl.	7K			×	×	×	Out-of-tolerance determination.	
50A	Clinostat	Monitor motor current.	Once/min.	 .	Negl.	7K			z		l	Out-of-tolerance determination.	İ
91	Mass Spectrometer	Monitor mass no. and peaks of trace contaminant and major atmospheric gases.		Continuous	600	52M	×	k	×	×	×	Transmissions to ground. Possibly some onboard analysis.	
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İ				DURATION	CONTINUOUS	DAILY	umch		hit		·	
EI	NAME		FREQ. OF	OF OPERATION	DATA RATE,	TOTAL,	Pro-l	ARCON	On-or	Descent	PROCESSING REQUIRED	REMARKS
7A							-		i I		1	
 '^	Auto. Poter. Elec. Anar	Measure pH, pCO ₂ , pO ₂ , K, Ca, Na, Ct, glucose	2/ 02	0.5 bar.	Negl.	5K			X		Conversion to cone. values. Downlink.	•
156	Signal Conditioners (12)	Monitor electrophysiological outputs such as ECG, EEG, etc.	24/day 6/day	10 min. 10 min.	3500/6 Chml. 700/6 Chml.	302.4M 15.1M 318 M	×	×	×	x :	Transmission to ground. Possibly some waveform analysis/ compression.	6 chmls - 500 sample s/ sec. 6 channels - 100 samples/sec.
80/81/ 83	Freezers/Refrig.	Monitor temperatures.	Once/10 min.		Negl.	9 K	×	×	x	x :	Out-of-tolerance determination.	2 channels, 5 bit/chal.
103B	Incubator	Monitor temperatures	Once/15 min.		Negl.	1.5K			I		Out-of-tolerance determination.	į.
182P	Ventilation Unit, Vertebrates	Monitor flows, pressures, humidities, etc., 3 mensors.	Once/min.		Negl.	22K	x	×	x	×	Out-of-tolerance determination.	
98A	Holding Unit, C&T	Monitor temp.	Once/min.		Negl.	7K			x	z z	Out-of-tolerance determination.	
50A	Clinostat	Monitor motor current.	Once/min.		Negl.	7K			×		Out-of-tolerance determination.	
91	Mass Spectrometer	Monitor mass no. and peaks of trace contaminant and major atmospheric gases.		Continuous	1200	104M	x	×	×	×	Transmission to ground. Possibly some onboard analysis.	·
98C	Holding Unit, Inverte.	Monitor temp.	Cuce/min.		Negl.	7K	x	╏	×	= =	Cut-of-tolerance determination.	
101	Holding Unit, Plants	Monitor temp., light current level	Once/min.		Negl.	14K	X	H	×	× ×	Out-of-tolerance determination.	·
93	Gas Analyzer, Water Vapor Specific	Measure resistivity of humidity sensors.	Once/min.		Negl,	7K	x		*	* *	Out-of-tolerance determination.	
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			FREQ. OF	DURATION OF	CONTINUOUS DATA RATE,	DAILY TOTAL	-luun	ju ju	orbit	Desternt		
EI	NÁME	MEASUREMENT DESCRIPTION		operation	DATA RATE.	bite	Pre	Asc	Ė	č	PROCESSING REQUIRED	REMARKS
64/65/	ECG, EEG, EMG Couplers	Conditions electrophysiological sig- nals from organisms or man.	16 chls - 24/day 6 chis - 4/day	10 min. 0.5 hr	700 @ 16 chls 3500 @ 6 chls 25.2 K	161M 151M 312 M		1 1		x x	Downlinking, waveform analysis,	Assume 6 high rate, id low rate chis.
	Signal Conditioners, Assorted Couplers	Miscellaneous physical and bio- physical measurements. Pressure, temps., flows, etc.	Once/min., 24 hrs/day		3	252K	x	×	×	I	x Downlink, out-of-tolerance determi- nation, display.	Assume 35 chls.
77B/80 81/83/ 163B	Freezers/Refrig.	Monitor temperatures	Once/10 min.		Negl.	15K		x	×	x	x Out-of-tolerance determination.	Assume 4 chis/Ei.
7	Antomalyter	Measures approximately 12 constituents of blood serum.	2/day	0.5	100	360K			×		Conversion to cone, values, Downlink.	
7A	Anto. Poten. Elec. Anal	Measure 8 properties of blood serum and/or urine.	2/day	0.5	Negl.	5K			×		Conversion to conc. values. Downlink.	
91	Mass Spectrometer(2)	Measure mass no. and peaks of trace contaminants and major atmospheric gases.		Continuous	600	52M	Ξ.	×	×	x	z Downlink. Possibly some on-board smalysis.	
93	Gas Analyzer, Water Vapor Specific	Measure resistivity of humidity sensors.	Once/min.		Negl.	7K	x	×	×	x	x Out-of-tolerance determination.	
65C	Electrophysiclogy Receiver	Monitors electrophysiological signals from subject.	1/day	1 hr	14 K	44.5M			×		Downlink, waveform analysis and display.	
153A	Rotating Litter Chair	EOG/EMG	2/mission	0.5 hr	6.5 %	11.7M			×		Downlink.	
ısc	Exercise Equi/Phy.	Monitor ergometer speed, output. Treadmill speed. Assume 1 chls.	2/day	1 hr	5 @ 4 chls	144K			×		Downlink, on board display & control. A	ssume 4 chls, 1 sample/ ec.
38F	Cardiopulmonary Analyza	Measure 6 gases used in breath-by- breath respiratory analysis.	2/day	0.5 hr	500 @ 6 chls	10.8M			*		Conversion to conc. values. Downlink	
117/ 139/31	LBNP, Limb Plethysmographs	Monitor pressures, temps., and Plethys. chis.	1/day	1 hr	35	126K			×			Assume 6 chis. Sample L/sec.

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1)	DURATION	CONTINUOUS	DAILY	Pre-Inunch	إيا	뒭	副]
1 1			FREQ. OF	OF	DATA RATE.	TOTAL,	<u>[</u>	Š	2	흵븒		
EI	NAME			OPERATION		bits	듸	4	9	<u> a la</u>		REMARKS
1823	VCG Coupler	Converts VCG signals	2/day	1 hr	21K	151M	1	ŀ	*		Downlink. On-board waveform analysis.	
1 1					!					1		
	Ventilation Unit,	Monitor flow, pressures, etc.	Once/min.		Negi.	43K	×	×	×	× 3	Out-of-tolerance determination.	<u></u>
1	Vertebrates	Est. 6 sensors.							- 1	1		
98A	Holding Unit, C&T	Monitor Temp.	Once/min.		Negl.	7K			× :	× ×	Out-of-tolerance determination.	
50A	Clinostat, C&T	Monitor motor current	Once/mtn.		Negl.	7K :					Out-of-tolerance determination.	j
DUA	Cimosut, Cer	Moditor motor current	Once/mm.		negi.	170	1 1		٦,		Out-or-interace desermination.	.
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PAYLOAD DEDICATED LAB - BIONEDICAL/BIOLOGY/ADVANCED TECHNOLOGY EMPHASIS NO. MOD HA

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_ 51_	NAME	MEASURELINN I PEOCRIP. ()	FREQ. OF	DURATION OF	CONTREGES DATA MATE.	DAILY TOTAL	Pre-launch	Ascont	On-orthit	Descent	Post-Inunch	PROCESSING REGULAÇÃO	renans
61/65 66	ECG, EEG, EMG Couplers	Conditions electrophysiological sig- nals from organisms or man.	16 chis - 24/day 6 chis - 4/day	10 mm. 0.5 hr	700 10 chls 3500 6 chls 25.2 K	16131 15131 31221	•			×	1	Downlinking, waveform analysis, data compression and display.	Assume 6 high rate, 16 low rate chis.
136/ 138B/ 143G/ 1A	Signal Conditioners, Assorted Couplers	Miscolianeous physical and bio- physical memts, pressure, temps., flows, etc.	Once/min., 24 hrs/day		3	259K	x	ж	×	×	x	Downlink, out-of-tolerance determi- nation, display.	Assume 35 chis.
77B/8 81/83 103B	o Freezers/Refrig.	Monitor temperatures	Once/10 min.		Negl.	15K	×	×	×	×	×	Out-of-tolerance determination.	Assume 4 chls/EI.
7	Autoanalyzer	Measures approximately 12 constituents of blood serum.	2/day	0.5	100	360K			×			Conversion to cone. values. Downlink.	
7A	Auto. Poten. Elec. Anal	Measure 8 properties of blood serum and/or urine.	2/day	0.5	Negl. -	5K			×			Conversion to conc. values. Downlink.	
91	Muss Spectrometer(2)	Measure mass no. and peaks of irace contaminants and major atmospheric gases.		Continuous	600	52M	×	×	×	x	x	Downlink, Possibly some on-board analysis.	
93	Gas Analyzer, Water Vapor Specific	Measure resistivity of humidity sensors.	Once/min.		Negl.	7K	×	×	×	×	×	Out-of-tolerance determination.	
65C	Electrophysiology Roceiver	Monitors electrophysiological signals	1/đay	1 hr	_4K	44.531			×			Downlink, waveform analysis and display.	
153A	Relating Litter Chair	EOG/EMG	2/mission	0.5 hr	6.5 K	1.7M			×	1		Downlink.	
18C	Exercise Eqmt/Pkg	Monitor Ergometer speed output, Treadmill speed. Assume 4 chis.	2/day	1 hr	5 € 4 chla	144K			×			Downlink, on board display & control	Assume 4 chis, 1 sample/sec.
38 F	Cardiopulmonary Analyzer	Measure 6 gases used in breath-by- breath respiratory malysis.	2/day	0.5 hr	500 & G chis	10.8M			×			Conversion to conc. values. Downlink.	
117/ 139	LBNP, Limb Plethysmographs	Monitor pressures, temps., and plethys. chis.	1/đay	l hr	35	126 K			Į.			On-board control of expmt- Downlink.	Assume 7 chls, sample/sec.

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EI	NAME		FREQ. OF OPERATION	DURATION OF OPERATION	CONTENUOUS DATA RATE, bps	DAILY TOTAL, bits	mup-o.id	Ascent	յդուօ-Ա	Descent Post-lumeh	PROCESSING ROLLINES	REMARKS
182J	VCG Coupler	Converts VCG signals.	2/da;	1 hr	21K	151M			х		Downlink. On Loard way't Liron	
182P	Ventilation Unit, Verts.	Monitor flow, pressures, etc. Est. 6 sensors.	Once/min		Negl.	435	×	x	x	X	analysis. Out-of-tolerance determination.	•
98A	Holding Unit, Cells & Tissues	Monitor temp.	Once/min		Negl.	7 1:			×	x x	Out-of-tolerance Convolution.	
50A	Clinostat, C&T	Monitor motor current	Once/min		Negl.	7K			x		Out-of-tolerance determination	İ
101	Holding Unit, Plants	Monitor temps., light levels	Once/min		Negl.	28K	x	×	ж	x x	Out-of-tolerance determ insticu.	Assume 4 chis.
50	Clinostat, Plant	Monitor motor current.	Once/min		Negl.	7K			×		Cut-of-tolerance determination.	
98C	Holding Unit, Invert.	Monitor temps.	Once/min		Negl.	7K	×	×	×	x	Out-of-tolerance determination.	
115F	LSS Test Console	Monitor temps., pressures, flows, currents, etc. Assume 10 chis.	Once/10 sec.	12 hrs - 10 chis; 12 hrs - 2 chi	1	216K 43K 259K			x		Out-of-tolerance determination. Downlini; exp. cata. Trend analysis.	
144	Psychomotor Perf. Console	Monitor sensor outputs which measure various psychomotor tasks such as tracking steadiness, pattern recognition.	1/day	6 hr	20К	432K			x		Statistical analysis. Downlink.	•
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PAYLOAD DEDICATED LAB - BIOMEDICAL/BIOLOGY/ADVANCED TECH./BIOCENTRIFUGE EMPHASIS NO. MOD HA

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EI	NAME	MEASUREMENT DESCRIPTION	FREQ. OF	DURATION OF OPERATION	CONTINUOUS DATA RATE, bus	DAILY TOTAL,		Ascent		Descont	Post-launch	PROCESSING REQUIRED	revarks
	ECG, EEG. EMG Couplers	Conditions electrophysiological sig- nals from organisms or man.	16 chis - 24/day 6 chis - 4/day	10 min. 0.5 br	700 € 16 chis 3500 € 6 chis 25.2 K		. 1	1 1		x	1 1	Downlinking, waveform analysis, data compression and display.	Assume 6 high rate, 16 low rate chis.
	Signal Conditioners, Assorted Couplers	Miscellaneous physical and bio- physical mamts, pressure, ten, flows, etc.	Once/min., 24 hrs/day		3	252K	ж	I	¥	×	x	Downlink, out-of-tolerance determination, display.	Assume 35 chis.
77B/80 81/83/ 103B	Freezers/Refrig.	Monitor temperatures	Once/10 min.		Negl.	15K	X	ž	×	x	I	Out-of-tolerance determination.	Assume chis/EI.
7	Autosnalyzer	Measures approximately 12 con- stituents of blood serum.	2/day	0.5	100	360K			x			Conversion to cone. values. Downlink.	
7A	Auto. Poten. Elec. Anal	Measure 8 properties of blood serum and/or urine.	2/day	0.5	Negl.	5K			x			Conversion to cone. values. Downlink.	
91	Mass Spectrometer(2)	Measure mass no. and peaks of trace contaminants and major atmospheric gases.		Continuous	600	52M	×	×	x	×	*	Downlink. Possibly some on-board analysis.	
a 1	Gas Analyzer, Water Vapor Specific	Measure resistivity of humidity sensors.	Once/min-	_	Negl.	7K	*	×	x	×	×	Out-of-tolerance determination.	
65C	Electrophysiology Receiver	Monitors electrophysiological signals	1/day	1 hr	14K	44.5M			X			Downlink, waveform analysis and display.	
153A	Rotating Litter Chair	EOG/EMG	2/mission	0.5 hr	6.5 K	1.7M			×		١	Downlink.	
18C	Exercise Eqmt/Pkg	Monitor Ergometer speed output. Treadmill speed. Assume 4 cbls.	2/day	1 hr	5 @ 4 chla	144K			x			Downlink, on board display & control.	Assume 4 chls, 1 sample/sec.
38F	Cardiopulmonary Analyzer	Measure 6 gases used in breath-by- breath respiratory analysis.	2/day	0.5 br	500 @ 6 chls	10.8M			×			Conversion to conc. values. Downlink.	·.
117/ 139	LBNP, Limb Plethysmographs	Monitor pressures, temps., and plethys. chis.	1/day	1 hr	35	126K			×			On-board control of expant. Downlink.	Assume 7 chis, sample/sec.

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E1	NAME	MEASUREMENT DESCRIPTION	FREQ. OF OPERATION	DURATION OF OPERATION	CONTINUOUS DATA RATE, bps	DAILY TOTAL, bits	Pre-lumch	Ascont	On-orbit	Descent Don't-lamoh	PROCESSING REQUIRED	REMARKS
	VCG Coupler	Converts VCG signals.	2/day	1 hr	21K	151M				Т	Downlink. On-board waveform	
182P	Ventilation Unit, Verts.	Monitor flow, pressures, etc. Est. 6 sensors.	Once/min		Negl.	43K	×	1		*	analysis.	·
98A	Holding Unit, Cells & Tissues	Monitor temp.	Once/min		Negl.	7K			×	x x	Out-of-tolerance determination.	
50A	Clinostat, C&T	Monitor motor current	Once/min		Negl.	7K			×		Out-of-tolerance determination	Ī
101	Holding Unit, Plants	Monitor temps., light levels	Once/min	1	Negl.	28K	×.	*	x	x x	Out-of-tolerance determination.	Assume 4 chis.
50	Clinostat, Plant	Monitor motor current.	Once/min		Negl.	7K			×		Out-of-tolerance determination.	ļ
98C	Holding Unit, Invert.	Monitor temps.	Once/min		Nogl.	7K	ж	×	× i	x x	Out-of-tolerance determination.	
115F	LSS Test Console	Monitor temps., pressures, flows, currents, etc. Assume 10 chis.	Once/10 sec.	12 hrs - 10 chls; 12 hrc - 2 chli	1	216K 43K 259K			*		Out-of-tolerance determination. Downlink exp. cata. Trend analysis.	
144	Psychomotor Perf. Console	Monitor sensor outputs which measure various psychomotor tasks such as tracking steadiness, pattern recog- nition.	1/day	6 hr	20K	432K			*		Statistical analysis. Downlink.	
43A	Bioresearch Centrifuge	Monitor and control speed, motor current, temps., balancing, ECS, etc.	-	Continuous 24 hrs/day	10	864K			*		Downlink, on-board display, caution/warning.	Assume 10 chis.
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PAYLOAD DEDICATED LAB - BIOLOGY EMPHASIS NO. MOD IIB

	MOD HB												
1									PPC ED		1		
			FREQ. OF	DURATION OF	CONTINUOUS DATA RATE,	DAILY TOTAL,	-				ost-launch	PROCESSING REQUIRED	REMARKS
	NAME ECG, EEG, EMG Couplers	MEASUREMENT DESCRIPTION Conditions electrophysiological sig- nals from organisms	16 chis - 24/day 6 chis - 4/day	OPERATION 10 mm. 0.5 hr	700 © 16 chis 3500 © 6 chis 25.2 K	hits 161M 151M 312M	x	×	1 1	x		Downlinking, waveform analysis, data compression and display.	Assume 6 high rate, 16 low rate chis.
	Signal Conditioners, Assorted Couplers	Miscellaneous physical and bio- physical memts, pressure, temps., flows, etc.	Once/min., 24 hrs/day		3	252K	*	х	×	x	X	Downlink, out-of-tolerance determination, display.	Assume 35 chis.
77B/80 81/83/ 103B	Freezers/Refrig:	Monitor temperatures	Once/10 min.		Negl.	15K	×	*	×	×	x	Out-of-tolerance determination.	Assumė 4 chis/EL
7	Autoanalyzer	Measures approximately 12 con- stituents of blood serum.	2/day	0.5	100	360K			×			Conversion to conc. values. Downlink.	
. 7A	Auto. Poten. Elec. Anal	Measure 8 properties of blood serum and/or urine.	2/day	0.5	Negl.	5K			×			Conversion to cone. values. Downlink.	
91	Mass Spectrometer(2)	Measure mass no. and peaks of trace contaminants and major atmospheric gases.		Continuous	600	52M	×	×	×	×	×	Downlink, Possibly some on-board analysis.	
93	Gas Anslyzer, Water Vapor Specific	Measure resistivity of humidity sensors.	Once/min.	-	Negl.	7K	×	×	×	x	×	Out-of-tolerance determination.	
180	Exercise Equit./Phys.	Monitor Ergometer speed, output, treadmill speed. Assume 4 chls.	2/day	1 hr	5 @ 4 chls	144K			×			Downlink, on-board display and ocatrol.	Assume 4 chis, 1 sample/sec.
182P	Ventilation Unit, Verts.	Monitor flow, pressures, temps., etc. Est. 6 sensors.	Once/min	_	Negl.	43K	×	k	x	¥	×	Out-of-tolerance determination.	
A86	Holding Unit, Cells & Tissues	Monitor temp.	Once/min		Negl.	7K			x	×	x	Out-of-tolerance determination.	
50A	Clinostat, C&T	Monitor Motor Current	Once/min		Negl.	7K		1	x			Out-of-tolerance determination.	·
101	Holding Unit, Plants	Monitor temps., light levels.	Once/min		Negl	28K	×	×	X	x	×	Out-of-tolerance determination.	·

PAYLOAD DEDICATED LAB - BIOLOGY EMPHASIS (Cont'd)
NO. MOD IIB

		· · · · · · · · · · · · · · · · · · ·					1	UPI	POR	T		
			FREQ. OF	DURATION OF	CONTINUOUS DATA RATE.	DAILY TOTAL	no-Intench	seent E	December 130	Post-launch	PROCESSING REQUIRED	REMARKS
EI	NAME	MEASUREMENT DESCRIPTION	OPERATION	OPERATION	. bp5	bits	F	<u> </u>	7	14.	PROCESSING REQUIRED	ALMMAN
•	Clinostat, Plants	Monitor motor current	Once/min		Negl.	7K		,	٠		Out-of-tolerance determination.	
C	Holding Units, Invert.	Monitor temp.	Once/min		Nogl.	7K	×	x 7	• ×	x	Out-of-tolerance determination.	
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DEDICATED LAB - BIOLOGY EMPHASIS

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Į i	·		FREQ. OF	DURATION OF	CONTINUOUS DATA RATE.	DAILY TOTAL	7	8	ē	12	讍	* *	!
EI	NAME	MEASUREMENT DESCRIPTION		OPERATION		bits	7.	Š	8	LE	Post-lumoh	PROCESSING REQUIRED	REWARKS
	ECG, EEG, EMG Couplers	Conditions electrophysiological sig- nals from organisms	16 chls - 24/day 6 chls - 4/day	10 min- 0.5 hr	700 © 16 chls 3500 © 6 chls 25.2 K	161M <u>151M</u> 312M	×	*	×	x	x	Downlinking, waveform analysis, data compression and display.	Assume 6 high rate, 16 low rate chis.
	Signal Conditioners, Assorted Couplers	Miscellaneous physical and blo- physical memts, pressure, temps., flows, etc.	Once/min., 24 hrs/day		3	252K	×	x	x	×	ax :	Downlink, out-of-tolerance determi- nation, display.	Asseme 35 chie.
77B/80 81/83/ 103B	Freezers/Refrig.	Monitor temperatures	Once/10 min.		Negl.	15K	×	×	×	×	×	Out-of-tolerance determination.	Assume 4 chls/El.
7	Autoenalyzer	Measures approximately 12 constituents of blood scrum.	2/day	0.5	100	360K			×			Conversion to conc. values. Downlink.	
7A	Auto. Poten. Elec. Anal	Measure 8 properties of blood serum and/or urine.	2/day	0.5	Negi.	5K			×			Conversion to conc. values.	
91	Mass Spectrometer(2)	Measure mass no. and peaks of trace contaminants and major atmospheric gases.		Continuous	600	52M	×	×	×	x	×	Downlink. Possibly some on-board analysis.	: :
93	Gas Analyzer, Water Vapor Specific	Measure resistivity of humidity sensors.	Once/min.		Negl.	7K	×	×	×	×	×	Out-of-tolerance determination.	*
180	Exercise Equit./Phys.	Monitor Ergometer speed, output, Treadmill speed. Assume 4 chls.	2/day	1 hr	5 @ 4 chls	144K			×			Downlink, on-board display and control.	Assume 4 chis, L sample/sec.
182P	Ventilation Unit, Vertebrates	Monitor flow, pressures, etc. Est. 12 sensors.	Once/min	-	Negl.	86K	×	ı	×	ļ,	×	Out-of-tolerance determination.	
					-								

PAYLOAD DEDICATED IAB - BIOMEDICAL EMPHASIS
NO. MOD IIIB

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	• •	·					t	NE	ED	ED	┙		'
EI	Name		freq. of operation	DURATION OF OPERATION	CONTINUOUS DATA RATE. bps	DAILY TOTAL, bits	Pre-launch	Ascent	On-orbit	Descent	Post-launch	PROCESSING REQUIRED	Remarks
	ECG, EEG, EMG Couplers	Conditions electrophysiological sig- nals from organisms	16 chis - 24/day 6 chis - 4/day	10 min. 0.5 hr	700 @ 16 chls 3500 @ n chls 25.2 K	161M 151M 312M	1 1	(I	1 1	x 3	- 1	Downlinking, waveform snalysis, data compression and display.	Assume 6 high rate, 16 low rate chis.
	Signal Conditioners, Assorted Couplers	Miscellaneous physical and bio- physical msmts, pressure, temps., flows, etc.	Once/min., 24 hrs/day		3	252K	×	x	x	x	×	Downlink, out-of-tolerance determi- nation, display.	Assume 35 chis.
77B/80 81/83/ 103B	Freezers/Refrig.	Monitor temperatures	Once/10 min.		Negl.	15K	×	×	x	x	*	Out-of-tolerance determination.	Assume 4 chis/EI.
2	Antoanalyzer	Measures approximately 12 constituents of blood serum.	2/day	0.5	300	360K			×			Conversion to cone. values. Downlink.	
7A	Auto. Poten. Elec. Anal	Measure 8 properties of blood serum and/or urine.	2/day	0.5	Negi.	5K			×			Conversion to cone. Values. Downlink.	
91	Mass Spectrometer(2)	Measure mass no. and peaks of trace contaminants and major atmospheric gases.		Continuous	600	52M	x	×	×	×	×	Downlink. Possibly some on-board analysis.	
93 .	Gas Analyzer, Water Vapor Specific	Measure resistivity of bumidity sensors.	Once/min.		Negl.	7K	×	×	×	×	×	Out-of-tolerance determination.	
18C	Exercise Equat/Phys.	Monitor Ergometer speed, output, Treadmill speed. Assume 4 chls.	2/day	1 hr	5 @ 3 chls	144K			×			Downlink, on-board display and control.	Assume 4 chis, 1 sample/sec.
182P	Ventilation Unit, Vertebrates	Monitor flow, pressures, etc.	Once/min.		Negl.	66K	×	k	×	×	×	Out-of-tolerance determination.	
43A	Bioresearch Centrifuge	Monitor and control speed, motor current, temps., balancing, ECS, etc.		Continuous 24 hr/day	10 -	864K			k			Downlink. On-board display. Caution/warning.	Assume 10 chis.

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APPENDIX F EI GSE REQUIREMENTS

APPENDIX F

EI GSE REQUIREMENTS

The following tables identify the GSE requirements of the equipment items (EIs) of the life sciences common equipment inventory. The EI's are grouped according to equipment units (EU). Spacelab (SL) and principal investigator (PI) equipment is not evaluated.

				ndling ortation			Servici Quipm				Chi	eckout	and Ma	intenar	ıce					iliary penent		Bps GSE Ex	cial	
Equipment Item	SL & PI Elb	Special Shipping Container	Transportation	Handling Equipment	Other	Pressurized Gas	Liquidis	Other	Monitor Equipment	Checkout Equipment	General Test Equipment	Pwr/Environ/ Sum. Simulator	Special Maint. Aids/Tools	General Tools	Calibration/ Checkout Gases	Lenk Test Equipment	Other	Automatic Checkout	Interface Equipment		Launch Operations		Post Mission	co & ment
EU I VISUAL RECORDS + MICROSCOPY 32 Camera, Cine 32A Camera, Controller 33 Camera, Polaroid 36 Camera, 35 MM + Strobe 37 Camera, Video B/W 38 Camera, Video, Color 38B Camera, Video, Color 38B Camera Mounts 38D Camera Timer, Video 75C Film, Cine 75F Film, Polaroid 76C Film, 95 MM 114E Lamp, Portable Hi Int, Photo 116 Log Books 126 Microscope, Compound										x x x	x x x x		х	x x x x x x x x										
126J Mcc. Access. Kit, Compad 134B Paper, Recording 150 Recorder, Strip Chart EU 2 DATA MANAGEMENT 14B Antennas, Assorted										x	x x			x x										
51 Calculator, Pockat 51 Computer, Digital 56A Data Mgmt Syst Buses 58A DMS Control + Display Station 58B DMS Remote Acquisition Unit	SL SL SL													x					Est Est Est Est					
63B Display Keyboard, Portable 63C Display, Numeric 64 ECG Coupler 65 EEG Coupler 66 EMG Coupler 126G Monitor, Video	SIL										x	x x x x		x x x x										
132 Oscilloscope and Camera 138B Photocell Coupler 143G Pressure Coupler 153 Recorder, Voice 156 Signal Conditioners (Couplers) 176 Tape, Video 180 Timer, Event	SL										x x x	-		X X X X								•		
181D Transducer, Pressure 182T Video Tape Recorder EU 3 LIFE SCI. EXPER, SUPPORT UNIT 1 Accelerometer	SIL .									x	x			X		`								

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	Ì	-		ndling a			ervici: quipme	-			Che	ekout :	ind Mai	intenar	ıce					liary pment		Spe SSE Eq	cial Vipens	ot.
Equipment Item	8L & Pi Ele	Special Shipping Container	Transportution	Handling Equipment	Other	Pressurfacd Gas	Liquids	Ciyo	Monitor Equipment	Checkout Equipment	General Test Equipment	Pwr/Environ/ Sum, Simulator	Special Maint. Aids/Tools	General Tools	Calibration/ Checkout Gases	Leak Test Equipment	Other	Automatic Checkout	Interface Equipment	Other	Launch Operations		Post Mission Operations	oc &
1A Accelerometer Coupler 6A Airflow Work Surface 51F Coolant Loop, Liquid 55A Crew Mobility Aids 55B Crew Restraints 55C Crew Work Station 70C Equipment Restraint	SL SL SL		:				x				X X X			x x x		x								
76J Flowmeter, Gas 93A Gas Supplies 114G Liquid Stor. + Disp. Sys. 116I Manifold, Vacuum 141A Plumbing 142B Power Cond. Equip. 178B Thermocouple Indicator 187A Waste Storage Device	SL SL						x			ж	x x x			x x x x		x x x x								
EU 4 PREPARATION + PRESERV, UNIT 40A Centrifuge, Bld Smpl Processor 44 Chemicals 44A Chemicals, Radioisot Tracers 70 Electrophoresis Apparatus 77B Freezer, Cryo. 20 Freezer, Gen 1 81 Freezer, Lo Temp 83 Frig. 96 Glove Box, Portable 96C Glove Box Liners 103B Incubator	SL	x						x x		x x x	x x x x			X X X X X X		ж							x	
105 Kit, Chemical 106 Kit, Hematologh + Urology 108 Kit, Histology 110 Kit, Microbiology 114 Kit, Microbiology 115 Lyophilizer 121 Mass Meas. Device (Macro) 122 Mass Meas. Device (Micro) 126 A Microscope, Dissecting 159 Staining Syst 179 Temp. Block 188 Work + Surgical Bench	PI	x				x	x x	-		x x x x	x x x x			X X X X X X X X X X X		х								
EU 5 BIOCHEM, + BIOPHYS, ANAL, UNIT 6 Air Particle Sample Collector 7 Autoanalyzer (Gemsaec)										x	x x	i		x x										

		1		ndling a			Servici quipma	_			Che	ckout =	nd Mai	ntenan	ce			·		liery ment		SE Eq	cia) alpine	pt
Equipment Item	St. & PI Ebs	Special Shipping Container	Transportution	Handling Equipment	Other	Pressurfzod Gas	Liquids	Other	Monitor Equipment	Checkout Equipment	General Test Equipment	Pwr/Environ/ Stim, Simulator	Special Maint. Aids/Tools	General Tools	Calibration/ Checkout Gases	Leak Test Equipment	Other	Automatic Checkout	Interface Equipment	Other	Launch Operations	Mission Operations	Post Mission Operations	Maintenance & Refurblebment
7A Auto Potentio. Elec. Anal. 11 Analyzer, Genl. Spectrophot. 15A Atmos. Sampling System 54 Counter, Colony Manual 76L Fibrometer, Blood Clot 87 Gas Analyzer, Infrared 91 Gas Analyzer, Mass Spec. 93 Gas Analyzer, RH 138 PH Meter 157 Sound Level Meter 179A Theromocuples 179D Thermometer, Portable Elect.	PI	TBD TBD		TBD			х			x x	x x x x x			X X X X X X X X	x x x	x								
EU 6 MAINT. REPAIR + FAB. UNIT 43 Cleaner, Vacuum 50B Compactor (Solids) 69A Electrometer 97C Handwipes, Betadyne (10 cm.) 106A Kit, Cleanup 109 Kit, Linear Meas. 113 Kit, General Tool 153B Sensors, Assorted 162 Sterilizer, Autoclave 165 Sterilizer, Tool 181G Trash Can 185 Multimeter	PI SL PI SL							-		•	x	x		xxx										
EU 7 ANCILLARY STORAGE UNIT 45 Chemical Storage Cabinet 167B Storage, Genl. 167C Storage, Film EU 11 EVA CAPABILITY UNIT 3B Airlock 158C Spacesuit Test Console 172 Spacesuit	SIL SIL PI PI PI																							
EU 23 INTERNAL CENTRIFUGE UNIT 43A Centrifuge, Life Sc. Research EU 26 RADIOBIOLOGY SUPPORT UNIT 16D Badges, Radiation (10 cc.)		х	x	x						x	x			x			:				тво	TBD	TED	TBO

Checkout and Maintenance

x x

x x

Servicing

Equipment

Special Hundling and

Transportation

TBD X

x

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Auditory Equipment

Special
GSE Equipmen

	Equipment Item	SL & PI EIS	Special Shipping Cont	Transportatio	Handling Equipment	Other	Pressurized C s	spph77	Other	Monitor Equipment	Checkout Equipment	General Test Equipment	Pwr/Environ, Stim, Simulat	Special Maint Aids/Tools	General Toole	Calibration/ Checkout Gas	Leak Test Equipment	Other	Automatic Checkou	interface Equipment	Other	Launch Operations	Mission Operations	Post Mission Operations	Maintenance i Refurblehmen
-	144 C Radiation Detector, Dosira. 147 Rad. Counter, Biochem. Sample 149G Rad. Source, Shielded EU 12 BIOMED/BEHAV. RES. SUP. UNIT 16B Audiometer 18D Custom Bite Boards 51D Control Console, Experimenter 65B Electrophys. Backpack 65C Electrophys. Receiver 131E Non-visual Direction Indicator 133 Otolith Test Goggles 144B Psychogalvanometer, GSR 163A Rotating Litter Chair/Console	PI PI PI PI PI PI			x		x				x	x x x	ж		x x x		x								
	EU 31 BIOMEDICAL RESEARCH SUP, UNIT 16F Ballistocardiogram Coupler 18C Exercise, Physiol. Equip. 19D Body Mass Mess. Device 38F Cardiopulmonary Analyzer 110C Kit, Human Physiology 117 LBNP 139 Plethysmograph, Limb 140 Phonovibracardiogram Coupler 156F Sono Cardiogram 182E Urine Volume Mess. Systm. 182J Vectorcard. Coupler	PI PI	TBD TBD X		X TBD X		x	x			x x x	x x x x x	x		x x x x x x									OKIGINAL TAGE OF FOOT	REPRODUCIBILITY
	EU 40 SMALL VERT. HOLDING UNIT 28 Cage, Total Metabolic, Rats 30A Cage, Rat, Hampster, Std 103 Hold. Unit, Sm. Vert. 131J Orb. Frog Otol. Exper. Package EU 41 PRIMATE HOLDING UNIT	ΡΙ			TBD			•			x	x	x		X X X		x x	:						MOOT OF	7 OF THL

x x x

101B Holding Unit, Monkey Pod 101C Holding Unit, Primate

114B Kit, Vertebrute Management 114C Kit, Vertrabrate Physiology

EU 42 VERT, RESEARCH SUPPORT UNIT 76G Physiol, Multichan, Sens Sys.

		Special Handling and Transportation					ervici: quipme		Checkout and Maintenance											liary ment		Spe SE Eq	cial uipmes	nt
Equipment Item	8L & PI K18	Special Shipping Container	Transportation	Handling Equipment	Other	Pressurfzed Gas	8pmbr1	Other	Monitor Equipment	Checkout Equipment	General Test Equipment	Pwr/Environ/ Stim. Simulator	Special Maint. Aids/Tools	General Tools	Calibration/ Checkout Gases	Lonk Test Equipment	Other	Automatic Checkout	Interface Equipment	Other	Launch Operations	Mission Operations	Post Mission Operations	Maintonance & Refurblehment
150B Receiver 174 Tank, Vertebrate Water 182P Ventilation Unit, Vert. 182R Vertebrate ECS			hed to	TBD H. U.	твр	TBD	x			x x x x	x x x			X X X		TBD X X								
EU 50 PLANT HOLDING UNIT 26B Cage, Metabolic Plant 29 Cage, Plant 101 Holding Unit, Plant 175 Tank, Plant/Invert, Water		TBD		TBD		-	x		x	x x	x x x			x x x x		TBD								
EU 51 PLANT RESEARCH SUPPORT UNIT 50 Clinostat 111 Kit, Plant Management 131D Motorized Plant Growth Monitor	Pi										x			х										
EU 60 CELLS/TISSUES HOLDING UNIT 25B Colony Chamber, Scalable 26A Cage, Metabolic, C/T 98A Holding Unit, Incub., C/T 187C Woodlawn Wanderer		тво		TBD						x	x x x x			x x x x										
EU 61 CELLS/TISSUES RES, SUP, UNIT 50A Clinostat (for C/T) 124 Media, Prepared											х			x										
EU 70 INVERTEBRATE HOLDING UNIT 14 Anesthetizer, Invert. 25 Cage, Invertebrates 98C Hold, Unit, Invertebrates 113A Kit, Invert, Management		TBD		TBD			-				x			x x x										
EU 80 LSS TEST UNIT 115F LSS Test Console 142 Portable LSS	PI PI	х		x		x	x			x	x			x		x								
EU 91 MSI MEASUREMENTS UNIT 15D Audio Stereo Headset 119 MSI Task Simulator 131H Optiscan - Field + Fixed 144 Psychomotor Perform, Console	PI PI PI									x	x			x										

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						1				EMEN.			<u></u>											
		1 1	Special Handling and Transportation				Servici: quipme		Checkout and Maintenance										Auxiliary Equipment		Special GSE Equipment			ıı
Equipment Item	SL & Pl Els	Special Shipping Container	Transportution	Handling Equipment	Other	Pressurized Gas	Liquida	Other	Monitor Equipment	Checkout Equipment	General Tost Equipment	Pwr/Environ/ Stim. Simulator	Special Maint. Aids/Tools	General Tools	Calibration/ Checkout Gases	Leak Test Equipment	Other	Automatic Checkout	Interface Equipment	Other	Launch Operations	Mission Operations	Post Mission Operations	Maintenance & Refurbishment
176H Taskboard, Force/Torque 182K Vision Tester	PI PI																			-				
EU 93 MOBILITY UNIT 15 Anthropometric Grid 122A Mass, Test, Variable Size 1261 Mobility Unit, Prot. Corridor				х										x										